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NOTES ON EDUCATION AND LIVESTOCK INDUSTRY OF NEW ZEALAND [1]

F. M. FRONDA [2]
Of the Department of Animal Husbandry

WITH FOUR TEXT FIGURES

New Zealand, a self-governing British Dominion that lies about 1,200 nautical miles (2,224 km.) southeast of Australia, is a very mountainous country. The islands forming the Dominion proper cover a total area of 103,415 sq. mi. (267,845 sq. km.).[3] Although New Zealand lies wholly in the temperate zone, the climate is mild; even in the middle of winter, it rarely snows at sea level. The bulk of the people, about ninety-four per cent, is of British and Irish descent, and only about five per cent Maori, the native population of the country. On April 1, 1939, there were 1,624,714 inhabitants in New Zealand, approximately eighty per cent of whom are New Zealand born.

School system. As in Australia, education in New Zealand is free, secular, and compulsory. All children from seven to fourteen years of age must be in school. In the primary classes, the child has to pass Standards I to IV and then proceed, in most cases, in the same school to the intermediate departments and take Forms I and II, after which he may, if he is fourteen years old, go straight to work. In most cases, however, the pupil is encouraged to enter Form III, especially if he is a country child. Some secondary schools are vocationalized, and evening classes are held to allow the pupils to become apprentices in some trades. If the pupil desires to acquire a higher education, he remains at post-primary school three or

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[1] General contribution No. 779.

[2] The help rendered by the New Zealand Government Tourist Bureau, the Dominion Department of Agriculture, the officials of Canterbury and Massey Agricultural Colleges, and various other individuals that made this tour of New Zealand economical both in money and time and at the same time highly profitable is hereby acknowledged.

[3] ANON. 1940. The New Zealand Official Yearbook, 1940, ix + 1041 p. Wellington, New Zealand: E. V. Paul, Government Printer.

The statistical figures given in this report were taken largely from this yearbook.

four years and then takes the university entrance examination. The University of New Zealand has branches in all the principal cities of the country.

Agricultural instruction. The University of New Zealand has two schools of agriculture, the Massey Agricultural College in North Island and the Canterbury Agricultural College in South Island. The Canterbury Agricultural College which has a farm that consists of nearly 1,300 acres (526.1 Ha.) was opened in 1880, whereas the Massey Agricultural College was not formally opened till 1928. This College has two farms, the College farm consisting of 925 acres (374.3 Ha.) and a leasehold hill country property of 1050 acres (424.9 Ha.).

In these colleges, both diploma and degree courses are offered. The diploma courses are intended to give the students a comprehensive knowledge of general agriculture. The students take part in the growing and handling of cereal and fodder crops, the management of the dairy herd and stud sheep, the production of fat lambs, the handling of farm implements, and other projects. The degree courses are intended for those who wish to take up agricultural science as a profession, and the subjects covered provide a valuable addition to "the practical training of the man who will be farming for a living". The degree courses in agriculture are recommended for those who can afford to spend the time taking them.

Short courses in the various branches of farming are also offered. For instance, at the Massey Agricultural College, short courses are offered in sheep farming, dairy farming, poultry farming, herd testing, wool classing, and domestic science. The length of these courses varies from one to forty-eight weeks. A short homemakers' course in domestic science is offered annually for three weeks, and its aims are "to deal with the everyday problems of the home in a sound, commonsense way without any unnecessary technicalities, and to give skill in home occupations, while at the same time arousing interest in them and developing intelligence". This course has proved interesting and useful for all girls who look forward to domestic life, either as a career in their own homes or in the homes of others.

In the degree course, not less than twelve months of practical farm work on a farm or in a dairy factory is required. The work, however, may be carried out during the summer vacations, but twelve months, although not consecutive, are required before the student can graduate with the degree of Bachelor of Agricultural Science.

Industries. New Zealand is largely a livestock country. The soil is fertile, and this combined with a favorable climate helps maintain prosperity in all farming operations. Large areas of native bush lands have been occupied for the production of wool. Fertile, easily cultivated lands have been tilled and converted into cropping and grazing farms. Large areas of forests have been cleared and sown with useful grasses for grazing purposes. The extent of the principal industries of the Dominion may be easily judged from the export figures of the country. In 1938, 93.9 per cent of the country's total exports were derived from her pastoral industry, and only 2.2 per cent from agriculture. The mining industry contributed 2.4 per cent of these exports and the forestal and other industries, 1.5 per cent.

Animal industry. The domestic animal population of New Zealand in 1939 consisted of the following:

KIND	NUMBER
Horses	274,803
Dairy cows	1,853,713
Cattle other than dairy cows	2,711,235
Sheep	31,897,091
Pigs	683,463
Poultry (figures for 1936)	4,019,076

Horses. The peak of New Zealand's horse-raising industry was reached in 1911. Since then, horse raising has declined considerably. Approximately fifty per cent of all horses raised in the Dominion are of the draught and three-quarter-draught type. It is claimed that the increased use of tractors on the farms has been mainly responsible for the decrease in the number of draught horses raised. Thoroughbred and other light working horses also have declined in number. The extensive development of road transportation facilities and the rapid increase in the number of motor vehicles are probably the cause of this decline. There are many motor vehicles in New Zealand, and it is claimed that in ratio of motor vehicles to population, the Dominion is surpassed only by the United States and Canada. In 1938, the number of motor vehicles licensed showed an average of one to every ten persons, or one car per two families.

Dairy cattle. The dairy industry of New Zealand compares very favorably with that of any progressive dairy country of the world. There are herd-book societies for the Jersey, Holstein Friesian,

Ayrshire, Milking Shorthorn, and Red Polled cattle. North Island accounts for about 86 per cent of all the dairy cows raised in New Zealand. The estimated yield of butterfat per cow in 1938-1939 of all dairy cows in New Zealand was 203.21 lbs. (92.4 kg.); of all cows that were in milk only, 215.94, lbs. (98.1 kg.).

The production, collection, treatment, preparation, and manufacture of dairy products either for local consumption or for export is regulated by the Dairy Industry Act. This Act provides that the cleanliness and sanitary condition of the premises where milk is produced must be satisfactory to the inspectors who are given ample powers to condemn any dairy product produced under unsanitary conditions. The Act also provides that butter for export must not contain more than 16 per cent water nor less than 80 per cent butterfat, and the export of cheese of which the water-free substance consists of less than 50 per cent fats wholly derived from milk is also illegal.

Beef cattle. The beef cattle industry has increased during recent years on account of the successful inauguration of the chilled beef exportation to the London market. Shorthorns predominate in New Zealand. There are also many fine herds of Hereford and Aberdeen-Angus. Herd-book societies have also been established for these breeds of beef cattle in the Dominion. Like dairying, North Island monopolizes the beef cattle industry of New Zealand. On this island, 87 per cent of all the beef cattle in the country are pastured. Most of these cattle are raised in the Wellington district.

Sheep. New Zealand, although a comparatively small country, ranks as the seventh country of the world in the number of sheep raised. In wool produced, the Dominion ranks as the fourth country, being out-ranked only by Australia, the United States, and Argentina. In 1939, there were 32,143 flocks of sheep in New Zealand, the average number in each flock being 992. A classification according to the size of these flocks showed that 15,264 flocks had 500 or less individuals; 14,249 had from 501 to 2,500; 2,469 had from 2,501 to 10,000; and 161 flocks had over 10,000.

The original breed of sheep raised in New Zealand is the Merino. By systematic crossing of the Merino-Leicester, locally known as the "Merino long-wool half-breed sheep", with the Lincoln, the Corriedale, a breed now well known all over the world, has been developed simultaneously with the Corriedale of Australia. The Romney Marsh, however, is at present the most popular breed, particularly

in North Island; and next to it is the Corriedale. There are also Southdown, Border Leicester, English Leicester, and Lincoln breeds.

A very little amount of the wool produced in New Zealand is used by the local woolen mills, the bulk of the Dominion's produce being exported (fig. 1). In 1939, the estimated production of wool in New Zealand was 327.7 million pounds (about 148 million kilos). About 50 per cent of this wool was shipped to the United Kingdom. The other principal countries that imported wool from New Zealand in 1938-39 are France, Germany, Japan, China, India, Australia, the United States, Canada, and Belgium.

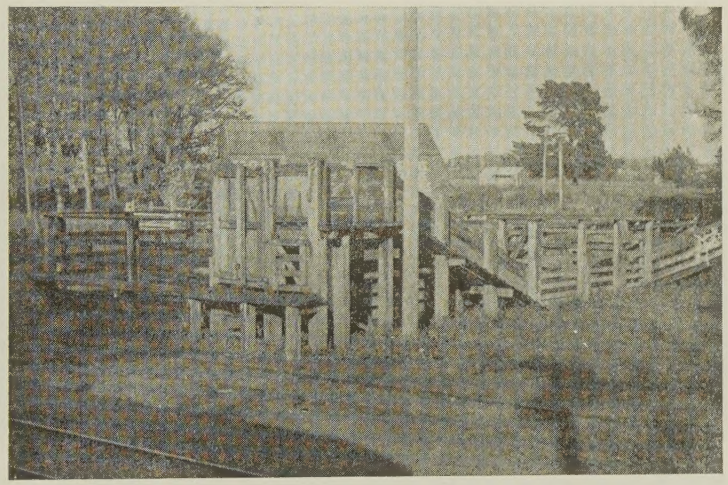

Fig. 1.—A sheep-loading platform. Railway stations in the rural districts in New Zealand are provided with these platforms.

Pigs. As in Australia, pigs are raised in New Zealand only as adjuncts of the dairies. There is still wide room for the expansion of the pig-raising industry in the Dominion. Berkshires lead all the other breeds of pigs raised in the country. Many of the pigs are Berkshires crossbred with other breeds. Approximately eighty per cent of the pig population of the country are of this type. Most of the pigs are raised in the dairy districts of North Island.

New Zealand pork, both frozen and chilled, is marketed entirely in the United Kingdom. A considerable amount of pig products is also exported as bacon, although in some cases, the curing is done in the United Kingdom. In 1938, about forty-nine per

cent of all frozen and chilled pork imported by the United Kingdom was from New Zealand.

Poultry. Poultry is raised in New Zealand mostly as a home industry. A survey of the poultry industry of the Dominion made in 1929 showed that about 94.0 per cent of the flocks contained less than fifty birds. In 1936, essentially similar conditions existed for the census figures showed that 80.8 per cent of the households had less than twenty-five birds, of which 39.6 per cent had less than twelve. In the entire country, there were only 3,219 households that had 100 or more birds, or a little under 2.0 per cent of the total, and there were 194 flocks with 1,000 or more fowls. Canterbury district in South Island is the center of the poultry industry

Fig. 2.—A flock of young S. C. White Leghorn pullets at the Canterbury Egg Farm, Christchurch, New Zealand. Courtesy of Mr. J. Liggins.

of New Zealand. This is the wheat region and without doubt, this contributes a great deal to the distribution of the fowls in the country.

The S. C. White Leghorn (fig. 2) is the leading breed of poultry in New Zealand, followed by the Black Orpington. There are many other breeds, but these are of minor importance. Because of a lack of a definite standard for the breed, the Australorp is not considered by most of the New Zealand poultry farmers as separate and distinct from the Black Orpington. In size, the fowls of the Dominion compare favorably with the best that may be found in Australia, and they are as heavy producers. Wheat bran and pollard form the base of the poultry rations. Meat meal can be ob-

tained within the country at a cost that is lower than in Australia. Great quantities of milk by-products are used by the poultry raisers. On a poultry farm visited near Christchurch, skim milk is delivered at 3 shillings (₱0.96) a drum of 45 gallons (170.3 l). From estimates made, however, it was found that it costs in feeds alone about 13 pence (₱0.35) to produce a dozen eggs, which amount is slightly higher than in Australia.

Poultry raising in New Zealand and the local sale and export of poultry and eggs (fig. 3) are regulated by the Poultry Act of 1924. This Act provides for the appointment of inspectors who are empowered to see that poultry is raised under sanitary condi-

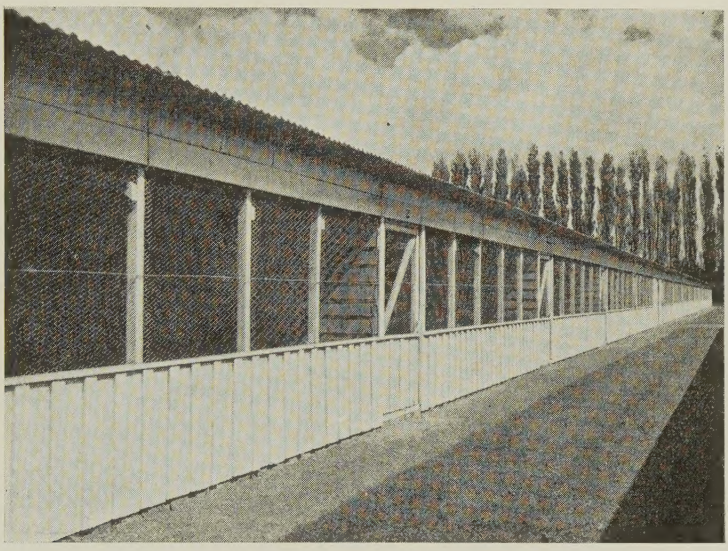

Fig. 3.—One of the long laying houses, Canterbury Egg Farm, Christchurch, New Zealand. Courtesy of Mr. J. Liggins.

tions (fig. 4). The Act also provides, among other things, that cruelty to poultry is an offence, that owners of poultry be required to notify an inspector within twenty-four hours of any outbreak of disease among their birds, and that they be required to comply with the inspector's directions.

In order to provide funds for the development of the industry, the Poultry-runs Registration Act was passed in 1933. This Act provides the compulsory registration of every poultry-run that has not less than twenty-five birds (hens and ducks not less than six months old). An annual registration fee of 2 shillings 6 pence

(₱0.80) is charged if the flock is over twenty-four but not more than one hundred head, and for each additional one hundred or a fraction thereof, there is an additional charge of the same amount. To administer this Act, the New Zealand Poultry Board has been established.

Pasture management. New Zealand pastures are exceptionally well maintained. They remain green even during the winter months. The pastures are carefully top-dressed and a considerable portion is sown annually. For this purpose, certified pasture seeds are now available. Of these seeds, there are four classes, namely,

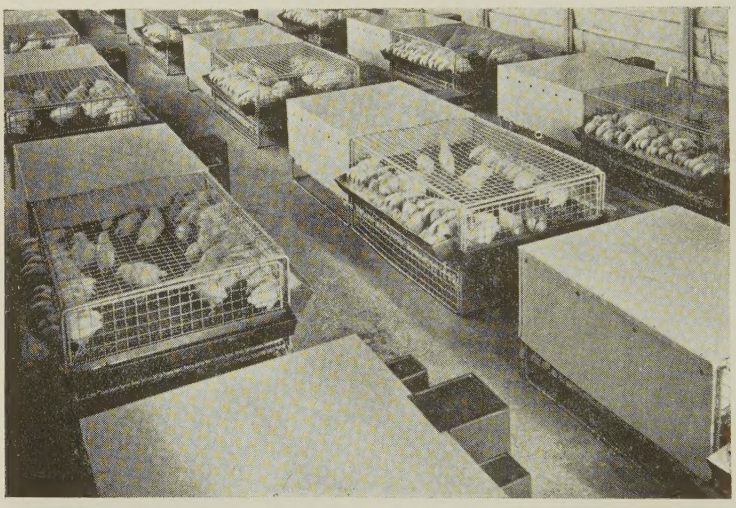

Fig. 4.—Kerosene brooders used on Sunny River Poultry Farm, Lower Hutt, New Zealand. Courtesy of Mr. G. I. Bews.

(*a*) Government Stock seed, (*b*) Pedigree seed, (*c*) Mother seed, and (*d*) Permanent Pasture seed. Government Stock seed is the direct product of specially selected strains; Pedigree seed is the product of areas that are sown with government stock seed; Mother seed is the product of areas sown with Pedigree seed or areas that have proved to be of desirable type; and the Permanent Pasture seed is the product either of areas sown with Mother seed or of other tested areas of equivalent merit. With the use of certified seeds, New Zealand farmers are able not only to have excellent pastures but also an excellent income from the harvest of these seeds.

Some livestock regulations. The livestock farmers of New Zealand are obliged to manage their stock according to rules and regulations contained in the Acts of Parliament. A summary of a number of those that may be of interest to stockmen in the Philippines follows:

a. Branding and earmarking. All brands must be registered. The branding of sheep consists of a wool mark and any one of the following: (1) earmark, (2) metal clip in the ear; (3) tattoo mark on the skin, and (4) firemark on the horn or on the face. After shearing and before April 30 of each year, all sheep and lambs must be branded or else a fine is paid not exceeding 10 shillings (₱3.25) for every animal not branded. Cattle, horses, or pigs that are within properties that are properly fenced need not be branded, but in other cases, they should be distinctly marked with a branding iron to which may be added an earmark, a tattoo mark, or a metal clip fixed to the ear.

b. Recovering stray stock. In open country, stock is liable to stray from one premise to another. When an owner believes some of his stock have strayed to another's land, he may apply to a livestock inspector who will order such other owner to muster his stock for identification purposes. A reasonable compensation must be paid. Without authority of the occupier, any person who drives or removes any stock from that land or goes upon any private land with a dog or a gun and disturbs any stock depastured thereon is liable to a fine.

c. Dipping sheep. Dipping of sheep is compulsory. Every owner of longwool or crossbred sheep must dip his sheep annually between January 1 and March 31 in North Island and between January 1 and April 30 in South Island unless he has previously secured an extension of 31 days which is permitted to cover difficulties like shortage of water or other reasonable causes. Owners of sheep infested with lice or ticks should neither allow their animals to stray on other land or on any highway nor should they offer their animals for sale. In case the animals are intended for slaughter, notice to dip may be postponed for 14 days.

d. Infectious and contagious diseases. Under this list of diseases are included actinomycosis, anthrax, cancer, catarrh, foot-and-mouth disease, glanders, hog cholera, mange, pleuro-pneumonia, rabies, rinderpest, scab, swine fever, trichinosis, tuberculosis, and also any tumor or growth which in the opinion of an inspector is of such

malignant or recurrent nature as to render unfit for human consumption the flesh or milk of the animal suffering therefrom. Inspectors are empowered to enter premises at any time and destroy or cause to be destroyed such stock, fodder, or fittings and prohibit the removal of stock from such areas. The owners are required to give notice to an inspector within 24 hours of any stock noticed to be diseased or suspected of disease. Where stock is slaughtered but found by the inspector not to be diseased, full market value up to £20 (₱130) per head of horses, £12 (₱78) of cattle, £2 (₱13) of pigs, and £1 (₱6.50) per head of sheep will be paid to the owner; but where found to be diseased, only one-half of the market value will be paid. No compensation, however, will be paid for imported stock if within six months of importation for horses less than one year or more than twelve years old, or for sheep or swine less than three months or more than four years old, when condemned.

e. *Slaughtering and meat inspection.* Local authorities of towns that have not less than 2000 inhabitants must establish an abattoir within 12 months of the publication of the statistics of population. Where there is no abattoir, registered slaughter houses may be established. Inspectors are appointed to see that all stock slaughtered are free from disease, and owners can claim compensation, in the cases of certain diseases, for part of the loss incurred owing to stock being condemned. The farmers must keep a record of all stock slaughtered for food and have this record open to inspection. They must not slaughter for barter or for sale in any week more than one head of cattle and five head of other stock unless authorized by an inspector in writing. Except in the case of pigs, the meat must not be sold to a butcher or to any one within three miles (4.8 km.) of a town. Fees are charged for slaughtering, and these should not exceed an amount sufficient to pay more than working expenses and 7 per cent on the capital expended in establishing and erecting the abattoir.

Research. New Zealand being primarily a livestock country, a considerable amount of research work is being done for the development of her pastoral industry. The Departments of Agriculture and Scientific and Industrial Research, the Canterbury Agricultural College at Lincoln, the Massey Agricultural College at Palmerston North, and the Dairy Research Institute situated at the Massey Agricultural College, all contribute to the solution of problems affecting the stockmen.

Extensive experiments are in progress at the Massey Agricultural College on problems affecting the sheep, particularly on the

sterility of the male. A flock of about 600 ewes has been set aside for this work. There are also herds of rams that are being maintained under different nutritional groups. These studies are made possible by grants from the New Zealand Romney Marsh Sheep Breeders' Association, the New Zealand Meat Producers' Board, and the Department of Scientific and Industrial Research. Investigations are also being made of the practical and economic aspects of intensive rotational grazing with sheep. In these investigations, drainage, top-dressing, and the establishment of good permanent pastures are some of the important features. Begun in 1936, the experiments were still in progress when the visit was made in May, 1940.

Studies on wool also occupy a considerable portion of the activities of the research staff of the Massey Agricultural College. The composition of the fleece both after and before birth is being studied in order to gain information on judging at an early age the nature of the fleece at later ages, thus providing a basis for breeding. A technique has been developed to determine the quantity of kemp in any sample of wool, and now efforts are being centered on the chemical treatment of wool to prevent shrinkage when washed with water. A card index system has been devised for the use of breeders in order to get the necessary information towards a systematic line-breeding and in-breeding for the best results.

The Dairy Research Institute. The Dairy Research Institute is the central dairy research organization of the Dominion. This organization is a unit of the Department of Scientific and Industrial Research and its policy is controlled by the Dairy Research Management Committee of the Research Council. The expenses of this Institute are borne jointly by the Dairy Produce Board and the Department of Scientific and Industrial Research. The Massey Agricultural College cooperates by providing for use its dairy factory, cowsheds, dairy equipment, and stock for experimental purposes. By agreement between the Dairy Research Institute and the Massey Agricultural College, some of the members of the Institute do both research and teaching work.

The Institute interests itself in matters affecting (*a*) the production of milk in relation to feeding, breeding, and management of dairy animals and factors affecting its purity, (*b*) the manufacture of dairy produce of all descriptions, (*c*) the utilization of dairy by-products, (*d*) the economic aspect of the production, manufacturing, and marketing of dairy produce, and (*e*) the investigation

of the suitability of types and models of dairy machinery, metals suitable for dairy machinery, and other engineering problems affecting the dairy industry. Facilities are also provided for the testing of dairy machines.

SUMMARY

1. New Zealand is a very mountainous country, and although it lies wholly in the temperate zone, the climate is mild.

2. In New Zealand, education is free, secular, and compulsory. All children from seven to fourteen years of age must be in school.

3. There are two agricultural colleges in New Zealand. In these colleges, both diploma and degree courses are offered. Short courses in the various branches of farming are also offered.

4. New Zealand is largely a livestock country. In 1938, 93.9 per cent of the country's total exports were derived from her pastoral industry, 2.2 per cent from agriculture, 2.4 per cent from mining, and 1.3 per cent from forestal and other industries.

5. The horse-raising industry of New Zealand is on the decline. Approximately fifty per cent of all horses raised in the Dominion are of the draught and three-quarter-draught type.

6. The dairy industry of New Zealand compares favorably with that of any progressive dairying country of the world. The estimated yield per cow in 1938-1939 of all dairy cows in New Zealand was 203.21 lbs. (92.4 kg.) of butterfat.

7. The beef cattle industry of New Zealand has increased during recent years on account of the successful inauguration of the chilled beef exportation to the London market. Shorthorns predominate in the Dominion.

8. New Zealand, although comparatively small, ranks as the seventh country of the world in number of sheep raised. In wool production, the Dominion ranks fourth, being out-ranked only by Australia, the United States, and Argentina. Romney Marsh is the most popular breed of sheep in New Zealand.

9. There is still wide room for the expansion of the pig-raising industry in New Zealand. Berkshire leads all the breeds of pigs in the Dominion.

10. Poultry is raised in New Zealand mostly as a home industry. The S. C. White Leghorn is the leading breed of poultry in the country.

11. New Zealand pastures are exceptionally well maintained. They remain green even during the winter months.

12. The livestock farmers of New Zealand are obliged to manage their stock according to rules and regulations contained in the Acts of Parliament.

13. Since New Zealand is primarily a livestock country, a considerable amount of research work is being done for the development of her pastoral industry. The Dairy Research Institute, a unit of the Department of Scientific and Industrial Research, is the central dairy research organization of the Dominion of New Zealand.

A COMPARATIVE STUDY OF NUTRIENTS OF NUTS OF PILI (CANARIUM OVATUM ENGLER)[1]

GLICERIO M. GARCIA

Pili, *Canarium ovatum* Engler, is one of the trees grown locally that produce nuts with high oil content (table 1). It is very abundant in southern Luzon, in several islands of the Visayan group, in Surigao, and other parts of Mindanao (Wester, 1916). The kernel has a very delicious flavor. It serves in the same manner as almonds, and is considered even superior by many. The oil is sweet, suitable for culinary purposes, and is used for making confections. The roasted kernels are used to adulterate chocolate, whereas the uncooked nuts have a purgative effect. The oil also possesses an antiseptic effect and contains anti-neuritic vitamin (Padilla and Soliven, 1933). The fruit may be obtained salted, sugared, or preserved in syrup. The last two preparations compare favorably with citron rind (Meyer, 1911). The pulp is also cooked and eaten. It contains oils, which are used in the Bicol Provinces for lighting and cooking.

Since nuts are usually grown for their oil content, the main interest, therefore, should be centered on the production of high oil-yielding trees. Because pili nut contains a high percentage of oils and a fair amount of proteins, it is becoming an important article of commerce. But it is possible that kernels produced by different trees might differ in their nutritive value. For propagation purposes, trees that produce kernels high in the constituents desired should be selected.

Brill and Agcaoili (1910) analyzed the kernels of pili nut and determined the constituents of the oil. Their results showed that the kernels contain about seventy-four per cent oils, and that the oil has an iodine value of from 186 to 192.

Wester (1916) found that the fruit is composed of 18.5 per cent kernel, 12 per cent proteins, and 4.75 per cent starch.

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[1] Experiment Station contribution No. 1424. Prepared in the Department of Agricultural Chemistry under the direction of Professor F. O. Santos.

Padilla and Soliven (1933) analyzed the kernels of pili nut and found that they contain 3.12 per cent moisture, 75.14 per cent fats, 4.49 per cent carbohydrates, and 17.75 per cent proteins.

Pili was found to respond very well to marcottage. Old branches proved better for this purpose than young ones. The branches rooted, whether the incision was made between the nodes or below them. Success was also attained by Cabrera [2] with inarching.

Austria (1932) worked on different methods of removal of husk of pili nuts, *Canarium ovatum* Engl. and *C. luzonicum* (Blm.) A. Gray and found that immersion in water at 40° to 50°C. was the most practical of all the methods used and that treatments with 5 and 10 per cent solutions of sulfuric acid and potassium hydroxide were equally effective in giving a good color to the nuts after the husk had been removed.

The objects of the study were (*a*) to analyze samples of pili nut kernels from different trees grown in the College, and (*b*) to determine the samples which are high in nutrients.

The work was conducted in the Department of Agricultural Chemistry from April, 1940 to January, 1941.

MATERIALS AND METHODS

Nuts

Twenty-eight composite samples of pili kernels from as many different individual trees were analyzed. The nuts were gathered from the pili trees in the Experiment Station. The trees are growing normally on a more or less similar type of soil and are exposed to similar environmental conditions. They were planted at the same time in 1920. Only the mature nuts, which were black, smooth, and shiny were gathered.

From 100 to 150 fruits were gathered from each tree to constitute one sample. The fruits were gathered from the top, side, and low branches. Because fresh samples were analyzed, samplings were done as the experiment progressed.

Procedure of analysis

All analyses were performed in quadruplicates, and the samples were analyzed according to the official methods of the Association of

[2] CABRERA, V. D. Some methods of propagation of pili *Canarium ovatum* Engl. and *C. luzonicum* [Blm.] A. Gray. (Thesis presented for graduation, 1932, with the degree of Bachelor of Science in Agriculture. Unpublished).

Official Agricultural Chemists (Anon., 1935) with some modifications as stated below.

Pulp. Samples containing 25 nuts each were weighed. The pulp was then removed, and the nuts, weighed. The difference in weight was recorded as the weight of the pulp.

Kernel. The nuts from the pulp determinations were then cracked, and the kernels, weighed. This represented the weight of the kernel.

Preparation of sample. The edible portion was ground with a meat grinder and mixed thoroughly. The ground product was then quartered, and from this, samples were taken for the analysis.

RESULTS AND DISCUSSIONS

The results are presented in tables 2 to 5. With the exception of the nitrogen-free extract, which was obtained by difference, and the calorific value per 100 grams of oven-dry sample, which was calculated, all the analytical data in table 2 were averages of quadruplicate determinations.

Proteins

The percentages of proteins (table 2) of the different samples varied from 12.064 ± 0.181 per cent, in tree No. 30 to 16.416 ± 0.204 per cent, in tree No. 24, with an average of 13.914 ± 0.158 per cent. The average obtained compares favorably with the results obtained by Wester (1916); the highest follows closely the result found by Padilla and Soliven (1933). Statistical comparisons were made among the four highest percentages, the four lowest percentages, the mean, and two percentages close to the mean (table 3). The difference between the highest percentage of proteins (tree No. 24) and the lowest (tree No. 30) was highly significant. This shows that there was considerable difference in protein contents between the samples taken from these trees. When the second highest (tree No. 7), third highest (tree No. 63), fourth highest (tree No. 69), and the highest percentages were compared, insignificant differences were found. A highly significant difference existed between the highest and the second lowest (tree No. 70). There was a significant difference between the third highest (tree No. 63) and the lowest. Insignificant differences, however, existed among the lowest, the second lowest (tree No. 70), the third lowest (tree No. 68), and the fourth lowest (tree No. 93). In spite of the fact that the trees from

which the samples were taken are grown in similar soil type and are exposed to similar environmental conditions, significant differences existed among the maximum, the mean, and minimum percentages (table 3). The mean was significantly lower than the maximum and significantly higher than the minimum. This shows, therefore, that some of the trees were high protein yielders; and others, low. An insignificant negative correlation (–0.056) was found between the percentages of kernels and the percentages of proteins; and an insignificant positive correlation, (+0.034) between the percentages of pulp and the percentages of proteins; hence, neither the percentages of pulp nor of kernel can be used as an index for the possible amount of proteins in the fruit.

Fats

The percentages of fats (table 2) ranged from 74.788 ± 0.188 per cent to 83.622 ± 0.224 per cent, with an average of 78.553 ± 0.288. The lowest percentage obtained compares favorably with the results found by Padilla and Soliven (1933), and Brill and Agcaoili (1910). Statistical comparisons were made among the maximum, minimum, mean, and those percentages just above and just below the mean (table 4). A significant difference between the highest percentage (tree No. 93) and the lowest (tree No. 63) was found. There was an insignificant difference between the third lowest percentage (tree No. 7) and the lowest. The same was true between the average and tree No. 2. However, between the average and tree No. 8, a significant difference was found. The highest was significantly higher than the second, third, and fourth highest percentages. This shows an irregular variation in the fat contents of the samples analyzed. The statistical difference between the maximum and the second highest (tree No. 74) was significant. Most of the percentages of fats of the samples analyzed were close to the average; and since the average found was higher than those found by Padilla and Soliven (1933), and Brill and Agcaoili (1910), they may all be considered high oil-yielding samples. Insignificant negative correlations were found between the percentages of pulp and fats (–0.086) and between the percentages of kernel and fats (–0.354); hence, neither the percentage of pulp nor the percentage of kernel can be used as an index for the possible amount of fats in the fruit.

Whether other pomological characters of the nuts are correlated with the oil content or not were not studied.

Crude fibers

The percentages of crude fiber (table 2) varied from 0.830 ± 0.034 per cent to 4.668 ± 0.053 per cent, with an average of 1.860 ± 0.104 per cent.

Statistical comparisons were made among the five lowest percentages of crude fiber (table 5). Insignificant differences occurred among the lowest (tree No. 93), second lowest (tree No. 2), and third lowest percentages (tree No. 24); and significant differences, among the lowest, fourth lowest (tree No. 28), and fifth lowest percentage (tree No. 90). The third lowest was insignificantly lower than the fourth lowest but significantly lower than the fifth lowest percentage.

Nitrogen-free extract

The percentages of nitrogen-free extract (table 2), which were obtained by difference, varied from 0.029 per cent to 5.816 per cent, with an average of 2.545 per cent. The highest percentage obtained was slightly higher than the result obtained by Padilla and Soliven (1933) and Wester (1916). There were irregular variations on all the percentages; however, this was possible because of the variations also in the fat contents of the samples.

Calorific value

Because the calorific values of the samples (table 2) were obtained by computation from the percentages of fats, proteins, and nitrogen-free extract, it was thought best to express the values in multiples of five. As shown in table 2, the calculations of the calorific values were based on 100 grams of oven-dry sample. The values varied from 740 to 800, with an average of 770 calories. The sample which gave the lowest calories per 100 grams of oven-dry sample, gave also the lowest percentages of fats, whereas the highest in the calorific values was also the highest in the fat content.

SUMMARY

1. Twenty-eight samples of kernels from twenty-eight different pili trees of the same age, growing on a more or less similar type of soil and exposed to similar environmental conditions were analyzed.

2. Statistically significant differences in composition were found among samples. The pulp ranged from 55.23 to 67.64, with an average of 62.26 per cent; kernel, from 15.59 to 26.54, with an average

of 20.59 per cent; moisture, from 11.08 to 35.06, with an average of 23.74 per cent; ash, from 2.78 to 3.52, with an average of 3.11 per cent; fats, from 74.79 to 83.62, with an average of 78.55 per cent; protein, from 12.06 to 16.42, with an average of 13.91 per cent; crude fiber, from 0.83 to 4.67, with an average of 1.86 per cent; nitrogen-free extract from 0.03 to 5.14, with an average of 2.55 per cent; and calorific value, from 740 to 800, with an average of 770 calories per 100 grams of oven-dry sample.

3. The highest protein-containing sample was taken from tree No. 24; the highest fat-containing sample, from tree No. 93; the highest nitrogen-free extract containing sample, from tree No. 8; and the sample with the highest calorific value, from tree No. 93.

4. The lowest protein-containing sample was taken from tree No. 30; the lowest fat-containing sample, from tree No. 63; the lowest nitrogen-free extract containing sample, from tree No. 93; and the sample with the lowest calorific value, from tree No. 74.

5. No correlation existed either between the percentages of pulp and of fats or between the percentages of pulp and of proteins. Neither was there correlation between the percentages of kernel and of proteins or between the percentages of kernel and of fats.

6. In the selection of trees for propagation, not only the analysis of the nuts must be taken into consideration, but also the yield of nuts.

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TABLE 1

Chemical composition of some Philippine oil-bearing seeds

OIL-BEARING SEED	AUTHORS	PROTEINS	FATS	CARBO-HYDRATES
		per cent	*per cent*	*per cent*
Aleurites moluccana (L.) Willd.	Padilla and Soliven (1933)	26.22	65.18	5.25
Aleurites moluccana (L.) Willd.	Aguilar (1919)	—	53.38	—
Aleurites moluccana (L.) Willd.	Richmond and Rosario (1907)	—	52.00	—
Aleurites trisperma Blco.	Padilla and Soliven (1933)	24.19	40.44	32.03
Aleurites trisperma Blco.	Aguilar (1919)	38.75	—	—
Aleurites trisperma Blco.	Brill and Agcaoili (1910)	9.00	44.12	—
Anacardium occidentale Linn.	Padilla and Soliven (1933)	27.48	43.39	22.78
Arachis hypogaea Linn.	" " " "	44.82	44.04	8.45
Calophyllum inophyllum Linn.	" " " "	8.87	84.00	5.60
Calophyllum inophyllum Linn.	Soliven (1924)	2.90	43.90	5.90
Canarium ovatum Engl.	Padilla and Soliven (1933)	17.25	75.14	4.49
Canarium pachyphyllum Perk.	Brill and Agcaoili (1910)	12.06	74.39	4.33
Canarium luzonicum (Blm.) A. Gray	" " " "	—	72.20	—
Chisocheton cumingianus (C. DC.) Harms	Padilla and Soliven (1933)	17.13	67.46	9.54
Cocos nucifera Linn.	" " " "	10.46	61.32	26.32
Hydnocarpus alcalae C. DC.	" " " "	21.08	67.42	7.10
Hydnocarpus hutchinsonii Merr.	" " " "	19.65	61.37	15.43
Hevea brasiliensis (HBK.) Muell.-Arg.	" " " "	19.94	45.77	31.03
Jatropha curcas Linn.	Soliven (1928)	23.35	51.89	—
Nephelium mutabile Blm.	Padilla and Soliven (1933)	16.99	63.98	16.16
Ricinus cummunis Linn.	" " " "	32.29	56.57	7.10
Sesamum orientale Linn.	" " " "	31.31	45.91	16.02
Sterculia foetida Linn.	Brill and Agcaoili (1910)	21.61	51.78	12.10
Sterculia foetida Linn.	Padilla and Soliven (1933)	25.58	54.85	15.89
Swietenia mahogani Jacq.	" " " "	16.52	62.90	17.69

TABLE 2

Analysis of nuts and kernels from twenty-eight pili trees

TREE NO.	NUTS		KERNELS						
	Pulp	Kernel	Moisture	Ash Oven-dry basis	Fats Oven-dry basis	Proteins Oven-dry basis	Crude fiber Oven-dry basis	Nitrogen-free extract oven-dry basis (by difference)	Calories per 100 grams sample oven-dry basis
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	
2	62.467 ± .205	16.695 ± .107	17.683 ± .111	3.120 ± .113	79.215 ± .430	14.791 ± .228	0.902 ± .041	1.972	780
4	63.685 ± 1.143	15.432 ± .190	21.986 ± .269	3.337 ± .033	78.648 ± .131	15.380 ± .128	1.181 ± .015	1.457	775
5	66.726 ± .257	26.539 ± .192	27.721 ± .135	3.114 ± .014	78.258 ± .757	13.898 ± .198	2.213 ± .074	2.517	770
7	62.534 ± .070	20.813 ± .373	24.222 ± .028	3.486 ± .029	75.411 ± .105	16.024 ± .196	2.037 ± .051	3.052	755
8	63.325 ± .059	16.755 ± .237	25.475 ± .292	3.099 ± .014	77.511 ± .182	12.411 ± .514	1.163 ± .102	5.816(h)	770
9	66.886 ± .161	20.468 ± .237	22.017 ± .050	3.238 ± .009	80.152 ± .210	14.872 ± .125	1.145 ± .062	0.595	785
12	59.312 ± .148	20.614 ± .131	23.195 ± .048	3.009 ± .037	76.430 ± .395	15.227 ± .116	1.744 ± .014	3.590	770
22	62.309 ± .749	15.590 ± .198	23.440 ± .079	2.856 ± .038	77.794 ± .196	15.002 ± .121	1.950 ± .010	2.398	770
24	64.102 ± .037	20.364 ± .122	21.233 ± .149	2.867 ± .040	78.708 ± .235	16.416 ± .204(h)	0.906 ± .026	1.102	780
28	55.226 ± .039	15.220 ± .090	22.370 ± .101	3.056 ± .330	81.019 ± .553	13.661 ± .194	0.981 ± .022	1.283	785
30	61.052 ± .145	22.739 ± .139	28.643 ± .102	3.014 ± .020	81.406 ± .614	12.064 ± .181(l)	1.866 ± .082	1.650	785
35	62.216 ± .620	24.648 ± .297	22.587 ± .079	2.933 ± .027	78.667 ± .159	13.062 ± .335	2.215 ± .141	3.123	770
37	66.916 ± .289	24.722 ± .250	28.001 ± .011	3.043 ± .068	76.767 ± .268	13.360 ± .159	1.695 ± .066	5.138	765
39	59.536 ± .130	17.914 ± .288	20.325 ± .075	3.163 ± 086	76.578 ± .580	13.551 ± .203	2.598 ± .109	4.100	760
50	63.528 ± .093	22.784 ± .170	20.522 ± .107	3.046 ± .014	80.779 ± .342	13.781 ± .095	1.704 ± .063	0.390	785
60	62.061 ± .288	20.794 ± .037	18.326 ± .078	3.071 ± .019	78.744 ± .184	14.478 ± .165	2.181 ± .101	1.526	770
61	58.512 ± .174	20.424 ± .137	27.791 ± .108	3.523 ± .098(h)	78.083 ± .477	12.885 ± .234	1.864 ± .138	3.645	770
63	62 487 ± .172	26.187 ± .181	31.158 ± .214	3.156 ± .076	74.788 ± .188(l)	15.817 ± .215	2.438 ± .071	3.618	750
66	65.407 ± .086	23.219 ± .231	29.918 ± .106	3.384 ± .067	78.268 ± .103	13.085 ± .195	2.231 ± .041	3.032	770
67	58.376 ± .356	20.310 ± .674	28.517 ± .045	3.218 ± .017	78.191 ± .386	13.293 ± .137	1.759 ± .232	3.539	770
69	67.644 ± .155	21.110 ± .205	26.042 ± .196	3.352 ± .013	75.827 ± .272	15.721 ± .277	2.534 ± .052	2.566	755
70	60.649 ± .332	20.437 ± .189	18.160 ± .109	2.776 ± .029(l)	81.074 ± .196	12.268 ± .117	1.492 ± .056	2.390	790
73	62.112 ± .158	20.972 ± .227	18.120 ± .091	3 084 ± .048	80.680 ± .642	12.573 ± .085	1.732 ± .051	1.931	785
74	59.973 ± .138	23.044 ± .143	35.058 ± .173	3.276 ± .017	74.917 ± .482	12.948 ± .163	4.668 ± .053(h)	4.191	740(l)
80	62.998 ± .576	23.978 ± .341	28.241 ± .062	3.010 ± .141	75.748 ± .242	13.711 ± .175	3.356 ± .101	4.175	755
83	60.431 ± .151	18.194 ± .153	11.082 ± .124	2.914 ± .013	80.902 ± .726	13.463 ± .177	1.628 ± .013	1.093	785
90	62.916 ± .054	18.791 ± .095	25.746 ± .092	3.004 ± .020	81.292 ± .204	13.282 ± .247	1.069 ± .028	1.353	790
93	63.915 ± .101	17.867 ± .124	22.018 ± .075	2.960 ± .007	83.622 ± .224(h)	12.559 ± .189	0.830 ± .034(l)	0.029(l)	800(h)
Average	62.261 ± .347	20.594 ± .406	23.736 ± .677	3.111 ± .024	78.553 ± .288	13.914 ± .158	1.860 ± .104	2.545	770

(h) = highest (l) = lowest

TABLE 3

Comparison of maximum, mean, and minimum percentages of proteins

TREE NO.	PERCENTAGES	COMPARISON	DIFFERENCES
24	16.416 ± 0.204 [a]	24:30	4:352 ± 0.273 (S)
30	12.064 ± 0.181 [b]	24:7	0.392 ± 0.283 (I)
7	16.024 ± 0.196	24:70	4.148 ± 0.235 (S)
70	12.268 ± 0.117	24:63	0.599 ± 0.312 (I)
63	15.817 ± 0.215	24:69	0.695 ± 0.344 (I)
68	12.411 ± 0.514	30:63	3.753 ± 0.281 (S)
69	15.721 ± 0.277	30:68	0.347 ± 0.545 (I)
93	12.559 ± 0.189	30:69	3.659 ± 0.331 (S)
66	13.085 ± 0.195	30:93	0.495 ± 0.262 (I)
Mean	13.914 ± 0.158	24:66	3.331 ± 0.282 (S)
		24:(m)	2.502 ± 0.258 (S)
		30:(m)	1.850 ± 0.241 (S)
		66:(m)	0.829 ± 0.251 (S)

[a]—Maximum
[b]—Minimum
(m)—Mean
(S)—Significant
(I)—Insignificant

TABLE 4

Comparison of maximum, mean, and minimum percentages of fats

TREE NO.	PERCENTAGES	COMPARISON	DIFFERENCES
93	83.622 ± .224 [b]	93:2	4.372 ± .485 (S)
63	74.788 ± .188 [b]	93:63	8.834 ± .292 (S)
30	81.406 ± .614	93:30	2.216 ± .653 (S)
74	74.917 ± .482	93:74	8.705 ± .532 (S)
90	81.292 ± .204	63:90	6.504 ± .277 (S)
7	75.411 ± .105	63:7	0.623 ± .215 (I)
70	81.074 ± .196	63:70	6.286 ± .271 (S)
80	75.748 ± .242	63:80	0.960 ± .306 (S)
Mean	78.553 ± .288(m)	93:(m)	6.111 ± .247 (S)
8	77.511 ± .105	93:8	5.069 ± .365 (S)
2	79.215 ± .430	(m):2	0.697 ± .518 (I)
		(m):8	1.042 ± .307 (S)
		(m):30	3.765 ± .377 (S)

[a]—Maximum
[b]—Minimum
(m)—Mean
(S)—Significant
(I)—Insignificant

TABLE 5

Comparison of lowest percentages of crude fiber

TREE NO.	PERCENTAGES	COMPARISON	DIFFERENCES
93	0.830 ± 0.034	93:2	0.072 ± .053 (I)
2	0.902 ± 0.041	93:24	0.076 ± .043 (I)
24	0.906 ± 0.026	93:28	0.151 ± .041 (S)
28	0.981 ± 0.022	93:90	0.239 ± .044 (S)
90	1.069 ± 0.028	24:28	0.075 ± .034 (I)
		24:90	0.163 ± .038 (S)

THE EFFECTS OF FERTILIZING BOTH THE SEED BED AND THE FIELD UPON THE YIELD OF ELON-ELON RICE [1]

CELSO C. SONGCUYA

One of the best commercial fertilizers tried with Elon-elon rice has been Corona Arroz, which, when applied in the field at the rate of 150 kgm. per hectare gave the highest yield. Whether or not the application of different amounts of Corona Arroz fertilizer in the seed bed in addition to 150 kgm. per hectare of the same fertilizer in the field would further increase the yield of Elon-elon rice is not known.

Results obtained by several workers on the influence upon the yield of the application of fertilizers on the seed bed do not seem consistent. For instance, Burton (1916) obtained lower yield in fertilized seedlings than in unfertilized ones, a result which he attributed to lodging caused by the fertilizer. Borja and Torres (1930) reported a decrease in yield in one experiment and an increase in another due to the application of fertilizer in the seed bed. Corcino [2] obtained considerable increase in yield as a result of applying different kinds of fertilizers in the seed bed.

The objects of this study were to determine the yield of Elon-elon rice and the profit or loss of (*a*) fertilizing the seed bed alone with different amounts of Corona Arroz, (*b*) fertilizing the field alone with 150 kgm. per hectare of Corona Arroz, and (*c*) fertilizing the seed bed with different amounts of Corona Arroz and the field with 150 kgm. per hectare of the same fertilizer.

This work was conducted from June, 1940 to January, 1941. The cultures were planted in the experimental lowland rice fields of the Department of Agronomy of the College of Agriculture, Los Baños.

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[1] Experiment Station contribution No. 1425. Prepared in the Department of Agronomy under the direction of the late Assistant Professor Vicente B. Aragon and of Dr. Valeriano C. Calma.

[2] CORCINO, BALTAZAR A. The production of lowland rice germinated in manured and unmanured seed beds. (Thesis presented for graduation for the degree of Bachelor of Agriculture from the College of Agriculture, 1922. Unpublished.)

MATERIALS AND METHODS

Variety and seed bed used. Selected seeds of the Elon-elon rice obtained from the Division of Annual Farm Crops of the Department of Agronomy were used. The land for the seed bed had an area of 1,000 square meters. It was divided into five equal plots of 200 square meters each for the different treatments and control. Corona Arroz said to contain N-9 per cent; P_2O_5-9 per cent; K_2O-4 per cent was used.

Rates of application on the seed bed and in the field. Four plots in the seed bed were fertilized each at the rate of 50, 100, 150, and 200 kgm. per hectare respectively. One plot was not fertilized and served as the control. With the exception of the control plots, the field was fertilized at the rate of 150 kgm. per hectare.

Culture. Following the ordinary method of lowland rice culture, the seed beds were prepared beginning July 10 and the seeds sown on July 16, 1940. The fertilized and control plants received identical treatments. Forty-six gantas of seeds were used.

Time and method of application of the fertilizer. The fertilizer was applied one day before the seeds were sown in the seed bed. One day before the fertilizer was broadcast in the field, the dikes of the different paddies were opened, and the water was drained off until an almost uniform depth of about one centimeter was left. Just before the fertilizer was broadcast, the dikes were closed to prevent the entrance of the water into the untreated plots. The field was supposed to be fertilized fourteen days after transplanting, but owing to the heavy rain, the fertilizer was applied twenty-three days afterwards.

The fertilizer was broadcast by hand on the seed bed and in the field as uniformly as possible.

The different lots or treatments and control were replicated five times and numbered I to X for the purpose of comparison. Lot I was planted with unfertilized seedlings and served as the control. Lots II, III, IV, and V were planted with seedlings fertilized with Corona Arroz at the rate of 50, 100, 150, and 200 kgm. per hectare, respectively. However, these lots were not fertilized in the field. Lot VI, with unfertilized seedlings, and lots VII, VIII, IX, and X were duplicates of treatments fertilized at the rate of 50, 100, 150, and 200 kgm. per hectare in the seed bed, respectively, and fertilized in the field at the rate of 150 kgm. per hectare.

RESULTS AND DISCUSSION

Observation of seedlings in the seed bed

Effects of fertilizer upon the appearance, growth, and vigor of the seedlings. Eight days after being sowed, the seedlings fertilized with 150 and 200 kgm. per hectare were dark green; those with 50 and 100 kgm. per hectare were green, and those of the control, yellowish green. When the seedlings were eighteen days old, hardly any difference was observed in the appearance, growth, and vigor of the different treatments including the control. When they were pulled up for transplanting, all the seedlings appeared uniform. However, the fertilized ones were harder to pull up than the control, especially those fertilized at the rate of 200 kgm. per hectare. This may be accounted for, in part, by the better root systems of the fertilized seedlings.

Effects of the different treatments upon the external appearance of the plants. The application of fertilizer in the field did not show any visible effect upon the growth, vigor, and color of the plants a few days after its application. The plants in the different treatments including the control did not exhibit marked differences in their vegetative growth. When the crop was approaching maturity, however, the rice panicles in the fertilized plots bent downward indicating a heavier yield.

Effects of the different treatments upon the degree of lodging. In general, the plants in all the treatments including the control did not lodge before they were transplanted and they exhibited slight lodging after they were transplanted. This was observed only in the lower portion of the paddy where water accumulated most of the time. But after the typhoons of December 9 and 10, 1940, lodging was considerably augmented in practically all plots.

Effects of the different treatments upon the tillering capacity. The number of bearing culms per hill among the different treatments did not differ significantly as shown in table 1.

The average number of bearing culms per hill as influenced by the different rates of fertilizer applied in the seed bed and 150 kgm. per hectare of the same fertilizer in the field are statistically treated in table 2. In that table the variance in number of culms per hill "between treatments" is insignificant, and that "between plots", sig-

nificant, indicating that the variation "between plots" has been the dominating factor in the experiment.

The number of bearing culms per hill as influenced by the application of 150 kgm. of fertilizer per hectare in the field alone is statistically treated in table 3; the difference "between treatments" is insignificant.

As a whole, tables 1, 2, and 3 show that the application of fertilizer in the seed bed alone, in both the seed bed and the field, or in the field alone did not materially influence the number of bearing culms per hill of Elon-elon rice. Another thesis student, Damian [3], who conducted a duplicate study at the same time on the same subject except for the variety, found the same result.

Relative effects of the different treatments upon the flowering and maturity of the plants. The plants of the different treatments and control began to flower 139 days after the seeds had been sowed in the seed bed, and matured 37 days later. This denotes that the application of fertilizer in the seed bed alone, in both the seed bed and the field, or in the field alone did not affect the flowering and maturity periods of the plants.

Yield obtained as influenced by fertilizing the seed bed alone

As a whole, the fertilized seedlings gave a higher yield than the unfertilized. When the results were analyzed statistically, however, as shown in table 4, the variation in yield "between treatments" was not the dominating factor in the experiment as it gave an insignificant difference.

This result is corroborated by Damian[4], who found the effects of fertilizer on the seed bed alone to be insignificant.

Yield obtained as influenced by fertilizing both the seed bed and the field

It will be noted in table 5 that there was a significant variation in yield due to treatments. In view of this, the critical difference between the mean yields of the treatments was computed. The re-

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[3] DAMIAN, ALFONSO J. The effects upon the yield of Ramai rice of fertilizing both the seed bed and the field. (Thesis presented for graduation, 1941, with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Unpublished.)

[4] See footnote 3.

sults are presented in table 5a. Only the plants fertilized at the rate of 100 kgm. per hectare in the seed bed and 150 kgm. per hectare in the field gave significant differences, the deviation from the control almost approaching the critical value of difference at 1 per cent level. This finding is at variance with the results of Damian [5], who reported that the application of fertilizer on the seed bed at 100 kgm. per hectare and 150 kgm. per hectare in the field gave an insignificant difference over the control.

Yield obtained as influenced by fertilizing the seed bed alone and fertilizing both the seed bed and the field

Table 6 shows that the variation in yield between treatments and those between plots were insignificant.

In table 7, it will be seen that the plants fertilized in the seed bed and in the field gave a significantly higher mean yield per plot than those fertilized in the seed bed alone.

The data presented in table 8 show that the plants fertilized in the seed bed and in the field gave a significantly higher yield per plot than those fertilized in the seed bed alone.

Table 9 shows that the plants fertilized in the seed bed and in the field gave a significantly higher yield than those fertilized in the seed bed alone.

Yield obtained as influenced by fertilizing the field alone

Table 10 shows that the variance influenced by "treatments" is significant and that influenced by "plots", insignificant. This result corroborates the findings of Pamintuan [6], who reported that the application of 150 kgm. per hectare in the field of the same fertilizer gave an increase of 23.8 per cent over the control. In the present work (table 12), the increase of the treated plot over the control is 23.5 per cent. On the other hand, this finding does not agree with those of Damian [7], who found that the application of 150 kgm. of Corona Arroz fertilizer did not give a significant difference over the control; the increase amounted only to 18 per cent.

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[5] See footnote 3.

[6] PAMINTUAN, MARIANO C. The effect of the application of different amounts of Corona Arroz fertilizer upon the yield of Ramai rice. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1933. Unpublished.)

[7] See footnote 3.

Other consideration affecting the yield

The damage done by the pests and diseases both in the seed bed and in the field was negligible.

The profit resulting from the different treatments

Table 11 shows the different expenses per hectare of fertilizer application. The plants fertilized in the field incurred greater expenses per hectare than those fertilized in the seed bed alone. However, in computing the profit and loss, only three items were considered; namely, (*a*) the cost of fertilizer and its transportation from Manila to the College of Agriculture, (*b*) the cost of applying the fertilizer in the seed bed and in the field, and (*c*) the current price of palay (Elon-elon) at the time the crop was harvested.

Table 12 presents the profit resulting from the different treatments. All the different treatments gave profits, which are arranged in their descending order.

LOT NO.	TREATMENTS		YIELD PER HECTARE	PROFITS	RANKS
	Rate per hectare of fertilizer in the seed bed	Rate per hectare of fertilizer in the field			
	kgm.	*kgm.*	*cavans*	*pesos*	
VIII	100	150	66.67	32.70	First
IX	150	150	64.60	26.35	Second
VII	50	150	62.70	20.17	Third
III	100	None	55.93	18.56	Fourth
VI	None	150	61.51	17.24	Fifth
II	50	None	54.18	13.28	Sixth
X	200	150	59.95	11.35	Seventh
IV	150	None	53.66	11.25	Eighth
V	200	None	53.01	8.99	Last

This tabulation shows further that the plants fertilized with 100 kgm. per hectare in the seed bed alone gave a profit greater than those obtained from plants fertilized with 200 kgm. per hectare in the seed bed and 150 kgm. in the field and those fertilized in the field alone. This is accounted for by the cost of fertilizer applied in the fields in the latter two treatments. It is interesting to note in this connection that with Ramai, Damian's [8] ranking of profit for

[8] See footnote 3.

the first three treatments consisted of the 150, 50, and 100 kgm. per hectare application in the seed bed and not any in the field.

SUMMARY

1. The different amounts of fertilizer applied in the seed bed alone, in both the seed bed and the field or in the field alone did not materially influence the flowering and maturity periods and the number of bearing culms per hill of Elon-elon.

2. In general, the plants fertilized in the field gave a higher yield than those unfertilized or fertilized in the seed bed alone.

3. Fertilizing both the seed bed and the field increased the yield of Elon-elon more than fertilizing the seed bed alone.

4. The treatment that gave the highest yield was the application of 100 kgm. per hectare in the seed bed and 150 kgm. per hectare in the field, the difference being significantly higher than the yield of the control.

5. The application of 150 kgm. of fertilizer per hectare in the field gave a significant increase in yield over the unfertilized seed bed and field.

6. The treatment that gave the highest profit of ₱32.70 was the application of fertilizer at the rate of 100 kgm. per hectare in the seed bed and 150 kgm. per hectare in the field.

7. Among the lots fertilized in the seed bed alone, that treated with 100 kgm. per hectare gave the highest profit of ₱18.56 per hectare followed by the one with 50 kgm. per hectare, with a profit of ₱13.38 per hectare.

LITERATURE CITED

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Galvez, N. L. 1936. Plant-food reserve in lowland and upland soils. The Philippine Agriculturist 25: 221–232.

TABLE 1

Analysis of variance for the number of bearing culms per hill as influenced by fertilizing the seed bed alone

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE, OR VARIANCE	ESTIMATE OF VARIANCE
Treatment	4	9.5953	2.3988	1.0023 [a]
Plot	4	12.2233	3.0558	1.2769 [b]
Error	16	38.2909	2.3931	
Total	24	60.1095		

[a, b] Values of F with 4 and 16 degrees of freedom are 3.01 for 5 per cent level of significance and 4.77 for 1 per cent level of significance.

TABLE 2

Analysis of variance for the number of bearing culms per hill as influenced by fertilizing the seed bed and the field

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE, OR VARIANCE	ESTIMATE OF VARIANCE
Treatment	4	7.5168	1.8792	1.4205 [a]
Plot	4	34.4538	8.6134	6.5109 [b]
Error	16	21.1678	1.3229	
Total	24	63.1384		

[a, b] Values of F with 4 and 16 degrees of freedom are 3.01 for 5 per cent level of significance and 4.77 for 1 per cent level of significance.

TABLE 3

Analysis of variance for the number of bearing culms per hill as influenced by fertilizing the field alone

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE, OR VARIANCE	ESTIMATE OF VARIANCE
Treatment	1	5.5951	5.5951	2.5750 [a]
Plot	4	0.5287	0.1321	0.0607 [b]
Error	4	8.6915	2.1728	
Total	9	14.8153		

[a] Values of F with 1 and 4 degrees of freedom are 7.71 for 5 per cent level of significance, and 21.20 for 1 per cent level of significance.

[b] Values of F with 4 and 4 degrees of freedom are 6.39 for 5 per cent level of significance, and 15.98 for 1 per cent level of significance.

TABLE 4

Analysis of variance for yields as influenced by fertilizing the seed bed alone

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE, OR VARIANCE	ESTIMATE OF VARIANCE
Treatment	4	419.82	104.9550	.7271 [a]
Plot	4	271.12	67.7800	.4695 [b]
Error	16	2309.46	144.3412	
Total	24	3000.40		

[a, b] Values of F with 4 and 16 degrees of freedom are 5.84 for 5 per cent level of significance and 14.15 for 1 per cent level of significance.

TABLE 5

Analysis of variance for yields as influenced by fertilizing the seed bed and the field

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE, OR VARIANCE	ESTIMATE OF VARIANCE
Treatment	4	667.7	166.9200	4.2961 [a]
Plot	4	236.3	59.0750	1.5204 [b]
Error	16	621.65	38.8531	
Total	24	1525.65		

[a, b] Values of F with 4 and 16 degrees of freedom are 3.01 for 5 per cent level of significance and 4.77 for 1 per cent level of significance.

TABLE 5a

Fisher's "t"—test for significance based on critical difference [a]

TREATMENT	DEGREES OF FREEDOM	DIFFERENCE BETWEEN TWO MEANS	REMARKS
VI vs. VII	16	2.62	Insignificant
VI vs. VIII	16	11.34	Significant
VI vs. IX	16	6.80	Insignificant
VI vs. X	16	3.44	Insignificant

[a] For 16 degrees of freedom, the value of "t" in Fisher's table are:
2.91 for 1 per cent level of significance
2.12 for 5 per cent level of significance

TABLE 6

Analysis of variance for yields as influenced by the application of 50 kgm. of fertilizer in the seed bed alone, and 50 kgm. of fertilizer in the seed bed plus 150 kgm. per hectare in the field

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE, OR VARIANCE	ESTIMATE OF VARIANCE
Treatment	1	879.836	879.8360	4.8211 [a]
Plot	4	166.846	41.7115	0.2285 [b]
Error	4	729.974	182.4935	
Total	9	1776.656		

[a] Values of F with 1 and 4 degrees of freedom are 7.71 for 5 per cent level of significance and 21.20 for 1 per cent level of significance.

[b] Values of F with 4 and 4 degrees of freedom are 6.39 for 5 per cent level of significance and 15.98 for 1 per cent level of significance.

TABLE 7

Analysis of variance for yields as influenced by the application of 100 kgm. per hectare of fertilizer in the seed bed alone, and 100 kgm. of fertilizer in the seed bed plus 150 kgm. per hectare in the field

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE, OR VARIANCE	ESTIMATE OF VARIANCE
Treatment	1	1394.77	1394.7700	18.9397 [a]
Plot	4	135.39	38.4750	0.5224 [b]
Error	4	294.57	73.6425	
Total	9	1824.73		

[a] Values of F with 1 and 4 degrees of freedom are 7.71 for 5 per cent level of significance and 21.20 for 1 per cent level of significance.

[b] Values of F with 4 and 4 degrees of freedom are 6.39 for 5 per cent level and 15.98 for 1 per cent level of significance.

TABLE 8

Analysis of variance for yield as influenced by the application of 150 kgm. per hectare of fertilizer in the seed bed alone, and 150 kgm. of fertilizer in the seed bed plus 150 kgm. per hectare in the field

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE, OR VARIANCE	ESTIMATE OF VARIANCE
Treatment	1	1449.61	1449.6100	15.1379 [a]
Plot	4	239.05	59.7625	0.6240 [b]
Error	4	383.04	95.7600	
Total	9	2071.70		

[a] Values of F for 1 and 4 degrees of freedom are 7.71 for 5 per cent level of significance and 21.20 for 1 per cent level of significance.

[b] Values of F with 4 and 4 degrees of freedom are 6.39 for 5 per cent level of significance and 15.98 for 1 per cent level of significance.

TABLE 9

Analysis of variance for yield as influenced by the application of 200 kgm. per hectare of fertilizer in the seed bed alone, and 200 kgm. of fertilizer in the seed bed plus 150 kgm. per hectare in the field

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE, OR VARIANCE	ESTIMATE OF VARIANCE
Treatment	1	282.161	582.1610	53.4475 [a]
Plot	4	507.671	126.9177	11.6489 [b]
Error	4	43.569	10.8922	
Total	9	1133.401		

[a] Values of F with 1 and 4 degrees of freedom are 7.71 for 5 per cent level of significance and 21.20 for 1 per cent level of significance.

[b] Values of F with 4 and 4 degrees of freedom are 6.39 for 5 per cent level of significance and 15.98 for 1 per cent level of significance.

TABLE 10

Analysis of variance for yield as influenced by fertilizing the field alone

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN SQUARE, OR VARIANCE	ESTIMATE OF VARIANCE
Treatment	1	1666.681	1666.6810	10.6068 [a]
Plot	4	238.031	59.5077	0.3787 [b]
Error	4	628.529	157.1322	
Total	9	2533.241		

[a] Values of F with 1 and 4 degrees of freedom are 7.71 for 5 per cent level of significance and 21.20 for 1 per cent level of significance.

[b] Values of F with 4 and 4 degrees of freedom are 6.39 for 5 per cent level of significance and 15.98 for 1 per cent level of significance.

TABLE 11

Expenses per hectare resulting from fertilizer [a]

TREATMENT	AMOUNT OF FERTILIZER USED		AMOUNT OF FERTILIZER USED PER HECTARE		TOTAL COST OF FERTILIZER PER HECTARE [b]	COST OF APPLICATION PER HECTARE [c]		TOTAL COST OF APPLICATION PER HECTARE	TOTAL EXPENSES PER HECTARE [d]
	Seed bed	Field	Seed bed	Field		Seed bed	Field		
	kgm.	*kgm.*	*kgm.*	*kgm.*	pesos	*pesos*	*pesos*	*pesos*	*pesos*
I	—	—	—	—	—	—	—	—	—
II	0.5	—	2.0	—	0.24	0.02	—	0.02	0.26
III	1.0	—	4.0	—	0.48	0 04	—	0.04	0.52
IV	1.5	—	6.0	—	0.72	0.06	—	0.06	0.78
V	2.0	—	8.0	—	0.96	0.08	—	0.08	1.04
VI	—	37.5	—	150	18.18	—	0.96	0.96	19.14
VII	0.5	37.5	2.0	150	18.42	0.02	0.96	0.98	19.40
VIII	1.0	37.5	4.0	150	18.66	0.04	0.96	1.00	19.66
IX	1.5	37.5	6.0	150	18.90	0.06	0.96	1.02	19.92
X	2.0	37.5	8.0	150	19.14	0.08	0.96	1.04	20.18

[a] 400 sq. m. of seed bed, planted 1 Ha. of field in the experiment.

[b] One sack of Corona Arroz fertilizer (50 kgm.); cost, ₱6.06, or 0.1212*c* per kgm.

Company's price ..... ₱5.90
Train and calesa to College 0.16

[c] Cost of applying fertilizer was ₱0.01 per kgm. in the seed bed, and ₱0.0064 in the field.

[d] Total cost of fertilizer per hectare plus total cost of application per hectare.

TABLE 12

Profit per hectare as influenced by the different treatments [a]

TREATMENT	AVERAGE YIELD PER HECTARE		INCREASE IN YIELD PER HECTARE	VALUE OF INCREASE IN YIELD PER HECTARE [b]	TOTAL EXPENSES PER HECTARE	PROFIT
	kgm.	*cavans*	*cavans*	*pesos*	*pesos*	*pesos*
I [c]	2190.4	49.78	—	—	—	—
II	2384.0	54.18	4.40	13.64	0.26	13.33
III	2461.2	55.93	6.15	19.08	0.52	11.56
IV	2361.2	53.66	3.88	12.03	0.78	11.25
V	2332.8	53.01	3.23	10.03	1.04	8.99
VI	2706.8	61.51	11.75	36.38	19.14	17.24
VII	2759.2	62.70	12.92	40.07	19.40	20.67
VIII	2933.6	66.67	16.89	52.36	19.66	32.70
IX	2842.8	64.60	14.92	46.27	19.92	26.35
X	2638.0	59.95	10.17	31.53	20.18	11.35

[a] The cost of fertilizer and application in the seed bed and in the field were the only expenses considered in the computation of profit.

[b] The current price of Elon-elon was ₱3.10 per cavan of 44 kilos.

[c] The control with unfertilized seed bed and field was used as the basis for computing the increase in cavans per hectare.

EDIBLE AND INEDIBLE PORTIONS IN THE DIFFERENT WHOLESALE CUTS OF WETHERS AND WETHER GOATS AT ONE AND A HALF YEARS OF AGE [1]

ABELARDO MABBAYAD GATAN

WITH ONE TEXT FIGURE

The principal object of this study was to compare the amount and percentage of lean and bones present in the different wholesale cuts of carcasses of sheep and goats. The amount and percentage of blood, internal organs, and offal in the same carcasses were also determined.

This study was started in November, 1933, and ended in January, 1936. It was conducted in the Department of Animal Husbandry.

MATERIALS AND METHODS

Animals

Five wethers and five wether goats were used in the study. The goats were Anglo-Nubian grades, while the sheep were grade Indians. The sheep averaged 2.8 kgm. at birth and the goats, 2.6 kgm. The weight of the sheep at the time of slaughter averaged 32.2 kgm.; that of the goats, 22.1 kgm. The average height of the sheep was 59.2 cm.; that of the goats, 63.8 cm.

Feeding and management

The animals were fattened separately from the time they were one year and three months old up to the age of one and a half years. The grain mixture used consisted of 5 parts, by weight, of ground corn, 3 parts copra meal, and 2 parts rice bran. Both sheep and goats were supplied concentrates in the evening in amounts that each would consume readily at each feeding time. Before the actual feeding operation was made, a preliminary trial was conducted for a period of one week to determine the amount of grain the animals would consume. From the result of this trial, it was found that

[1] Experiment Station contribution No. 1426. Prepared in the Department of Animal Husbandry under the direction of Associate Professor Valente Villegas.

the amount of concentrates consumed by the sheep was one and a half per cent of their live weight; and in the case of goats, one per cent.

All the animals obtained their forage feed in the pasture during the day time. On rainy days they were kept in the barn and given roughage, which consisted of napier and mixed grasses.

Water was accessible to the animals at noon and at night when they were brought into the barn from the pasture. Salt was given three times a week.

Slaughtering

Previous to the day of slaughter, each animal was fasted for a period of 24 hours. The animals were weighed before and after fasting. To obtain a more accurate weight, the sheep were sheared before slaughter. The animals were killed and bled by sticking the point of a knife into the throat between the head and the neck close to the ears. All the blood that could be removed was collected in a receptacle and weighed. Immediately after dressing, the carcass was placed in a refrigerator with an average temperature of 10.55°C. (51°F.), for a period of 48 hours, then it was divided into wholesale cuts; namely, the chuck (including the neck), the breast (including the shanks), the hotel rack, the loin, the legs, and the flank (fig. 1). The different internal organs like the heart, lungs, liver, spleen, and kidneys were separated. The four compartments of the stomach and the intestines were also separated and cleaned thoroughly. From the head, the brain was removed, and the tongue was cut off at the base. The fat covering the kidneys and the viscera was collected and designated as *caul*. The waste included the four shanks, the head (without the lean, tongue, and brain), and the skin.

Removal of bones

The edible portions were separated from the different wholesale cuts. Care was taken to separate as much as possible the lean from the bones. The edible and inedible portions were weighed in a "Buffalo" meat scale soon after they had been separated.

RESULTS AND DISCUSSION

Loss of weight and percentage of shrinkage

After fasting the animals for 24 hours, the loss of weight in sheep ranged from 0.9 to 1.2 kgm., or an average of 1.0 kgm. The

shrinkage varied from 2.63 to 4.44 per cent, or an average of 3.30 per cent. The average loss of weight in goats was 1.5 kgm. The

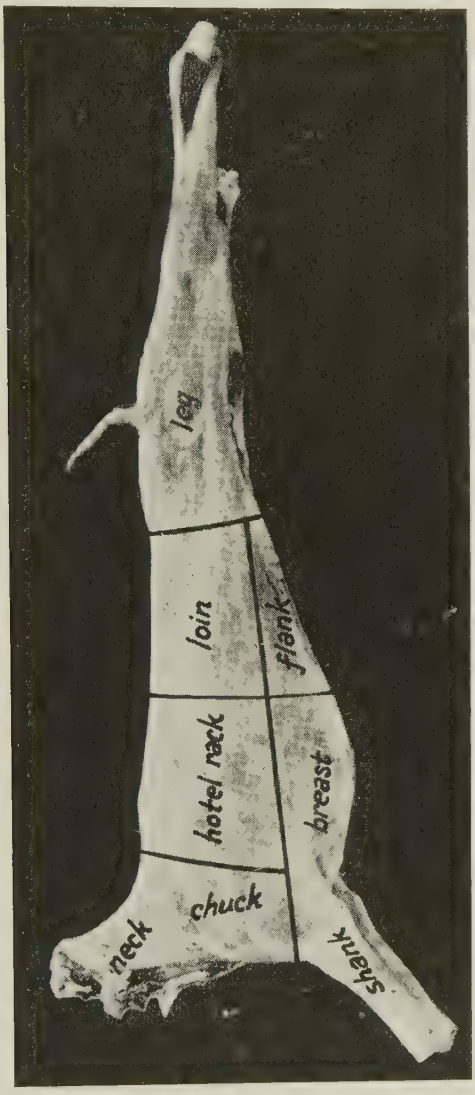

Fig. 1.—Wholesale cuts

range was from 1.4 to 1.6 kgm. The shrinkage varied from 5.75 to 8.16 per cent, or an average of 6.79 per cent. The shrinkage was consistently greater in goats than in sheep.

Dressed weight and dressing percentage

The dressed weight of sheep varied from 13.6 to 20.0 kgm. with an average of 16.4 kgm. In goats, the average dressed weight was 11.40 kgm. It ranged from 10.0 to 13.40 kgm. The dressing percentage in sheep varied from 50.0 to 52.63 per cent, with an average of 51.28 per cent. Helser [2] states that a sheep dresses from 40 to 69 per cent; ordinarily, however, the dressing percentage is from 45 to 55 per cent. In goats, the range was from 50.00 to 53.60 per cent with an average of 51.43 per cent. According to Villegas [3], the dressing percentage of goats at the College ranged from 36.1 to 50.0 per cent with an average of 43.35 per cent. It is interesting to note that sheep are heavier than goats and that both have about the same dressing percentage at the age of one and a half years.

Offal

The amount of offal obtained from sheep was greater than that from goats. It varied from 7.79 to 10.69 kgm., with an average of 9.07 kgm. in sheep. In goats, the amount ranged from 5.52 to 6.60 kgm., with an average of 5.89 kgm. The relation of offal to the dressed carcass of sheep represents, on an average, a ratio equivalent to 55.29 per cent, with a range of from 49.61 to 60.59 per cent. In goats, the range was from 44.33 to 57.50 per cent, with an average of 52.29 per cent.

Waste

The waste from sheep amounted to an average of 3.50 kgm. and the range was from 3.04 to 3.87 kgm. In goats, the fluctuation was from 2.63 to 2.98 kgm. with an average of 2.81 kgm. In relation to the dressed carcass, the variation was from 18.89 to 23.41 per cent in sheep; the average was 21.37 per cent. In goats, the average was 24.98 per cent with a range of from 20.89 to 28.60 per cent. It is evident, therefore, that the quantity of waste was consistently greater in sheep than in goats. The ratio to the dressed carcass, however, was greater in goats than in sheep.

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[2] HELSER, M. D. 1923. Farm meats. 274, 125 fig. New York: The Macmillan Company.

[3] VILLEGAS, VALENTE. 1932. Goat raising. The Philippine Agriculturist 21: 36-52. *Also* College of Agriculture Circular 22: 17 p.

Wholesale cuts

The quantity and percentage of the different wholesale cuts of sheep and goats are shown in table 1.

Chuck, including neck. The weight of the chuck in the sheep varied from 2.97 to 4.67 kgm., with an average of 4.05 kgm. In goats, the average was 2.69 kgm.; the variation was from 2.33 to 3.35 kgm. In relation to the dressed carcass, the chuck in sheep amounted to 24.60 per cent and the range was from 21.84 to 28.93 per cent. In goats, the percentage was 23.59, with a variation of from 22.08 to 25.40 per cent.

Hotel rack. The hotel rack of sheep averaged 2.01 kgm., and the fluctuation was from 1.47 to 2.64 kgm. In goats, it varied from 0.89 to 1.50 kgm., with an average of 1.23 kgm. Based on the weight of the dressed carcass, the average percentage of the hotel rack amounted to 12.56, with a range of from 10.50 to 14.06 per cent. In goats, the hotel rack varied from 8.90 to 11.68 per cent, with an average of 10.72 per cent.

Loin. The average weight of loin obtained from sheep was 1.95 kgm., with a range of 1.38 to 2.57 kgm. In goats, the fluctuation was from 0.81 to 1.33 kgm., with an average of 1.09 kgm. Expressed in percentage, the loin of sheep was, on an average, 11.66 per cent of the dressed carcass, with a variation of from 9.86 to 12.85 per cent. In goats, the variation was from 8.10 to 10.30 per cent and the average was 9.56 per cent.

Breast including shanks. The breast including the shanks of sheep amounted to from 1.72 to 3.45 kgm., with an average of 2.58 kgm. In goats, the average was 2.07 kgm., with a range of from 1.85 to 2.27 kgm. In relation to the dressed carcass, it varied from 12.29 to 19.49 per cent in sheep, with an average of 15.60 per cent. In goats, it ranged from 16.94 to 19.60 per cent, with an average of 18.33 per cent.

Legs. The legs were the heaviest of all the cuts in both sheep and goats. In sheep, they varied from 4.26 to 5.82 kgm., with an average of 5.16 kgm. In goats, they were from 3.41 to 4.60 kgm., with an average of 4.00 kgm. This represented a ratio of from 29.10 to 34.40 per cent of the dressed carcass of sheep, with an average of 31.42 per cent. In goats, the average percentage was 35.13; the variation was from 34.10 to 36.08 per cent.

Flanks. The flanks of sheep varied in weight from 0.59 to 0.85 kgm., with an average of 0.68 kgm. In goats, the average was 0.30 kgm. and the range was 0.26 to 0.35 kgm. The ratio to the dressed carcass averaged 4.16 per cent, with a range of from 3.94 to 4.38 per cent. In goats, the variation was from 2.50 to 2.82 per cent, with an average of 2.67 per cent. This cut is the lightest in both sheep and goats.

Edible portions of wholesale cuts

Table 2 shows the edible portions of lean of the different wholesale cuts of the animals.

Chuck, including neck. The amount of meat obtainable from the chuck in sheep varied from 2.42 to 3.69 kgm., with an average of 3.23 kgm. In goats, it varied from 1.70 to 2.47 kgm., with an average of 1.93 kgm. The amount is uniformly greater in sheep than in goats. Expressed in percentage, the proportion of the edible portion to the total weight of chuck in sheep was from 78.16 to 82.72 per cent, with an average of 79.99 per cent. In goats, it varied from 69.67 to 73.82 per cent and the average was 71.76 per cent. The ratio of meat to the dressed weight averaged 19.69 to 23.93 per cent; in goats, it was from 15.44 to 18.43 per cent; the average was 16.84 per cent.

Hotel rack. The lean in the hotel rack of sheep varied from 1.0 to 2.17 kgm., with an average of 1.60 kgm. In goats, the average was 0.82 kgm., which is about one-half that in sheep. The range was from 0.56 to 1.01 kgm. In terms of percentage, the quantity of lean to the weight of hotel rack in sheep averaged 76.29 per cent, with a range of from 68.03 to 82.19 per cent. In goats, it varied from 62.92 to 69.03 per cent, with an average of 66.52 per cent. The ratio of lean to the dressed weight averaged 9.64 per cent; the variation was from 7.14 to 11.17 per cent in sheep. In goats, it ranged from 5.60 to 7.92 per cent, with an average of 7.15 per cent.

Loin. An average amount of 1.65 kgm. of lean was obtained from the loin of sheep, and the variation was from 1.04 to 2.26 kgm. In goats, the range was from 0.58 to 0.95 kgm., with an average of 0.78 kgm. These amounts represent an average of 83.80 per cent and a range of from 75.36 to 88.16 per cent of the weight of the loin of sheep. In goats, it varied from 68.93 to 73.39 per cent, with an average of 71.55 per cent. The ratio of lean to the total dressed carcass of sheep averaged 9.77 per cent, with a range of from 7.43 to

11.30 per cent. In goats, the variation was from 5.80 to 7.28 per cent and the average was 6.84 per cent.

Breast, including shanks. The amount of lean obtained from the breast including shanks, in sheep varied from 1.24 to 2.85 kgm., with an average of 2.07 kgm.; in goats, it amounted to an average of 1.49 kgm., with a range of from 1.39 to 1.68 kgm. In percentage, it amounted to an average of 79.63, and the fluctuation was from 72.09 to 82.76 per cent. In goats, the range was from 68.35 to 75.14 per cent, with an average of 71.92 per cent. The ratio to dressed weight in sheep averaged 12.47 per cent; the variation was from 8.86 to 15.22 per cent. In goats, an average of 13.18 per cent was obtained, and the range was from 11.92 to 14.10 per cent.

Legs. The legs of both sheep and goats were found to possess the maximum amount of edible portion among the various wholesale cuts. In sheep, the amount of edible portion varied from 3.52 to 4.97 kgm., with an average of 4.32 kgm. In goats, the average amount was 3.16 kgm., and the range was from 2.76 to 3.57 kgm. The proportion of meat to the whole leg of sheep was from 79.71 to 85.39 per cent, with an average of 83.55 per cent. In goats, the average percentage was 79.17; the fluctuation was from 77.61 to 80.94 per cent. The ratio of meat in the legs to the total dressed weight in sheep varied from 24.85 to 27.21 per cent, with an average of 26.22 per cent. In goats, it fluctuated from 26.64 to 28.45 per cent with an average of 27.82 per cent.

Flanks. The average weight of the flanks of sheep was 0.68 kgm. The smallest size was 0.59 kgm. in weight and the biggest, 0.85 kgm. In goats, it was less than one half that of sheep and ranged from 0.25 to 0.35 kgm., with an average of 0.30 kgm. Its ratio to the total dressed weight in sheep ranged from 3.94 to 4.38 per cent, with an average of 4.16 per cent. In goats, the variation was from 2.50 to 2.82 per cent and the average was 2.67 per cent.

To summarize, it is evident that the quantity of edible portion in the different wholesale cuts of sheep is consistently greater than in those of the goats at one year and a half of age. In both sheep and goats, the legs gave the greatest amount of edible portions among the various wholesale cuts. The least amount was in the flanks. The total amount of meat in sheep was, on an average, 13.55 kgm.; and in goats, 8.48 kgm. The ratio of the total amount of meat to the entire

dressed carcass averaged 81.95 per cent in sheep and 74.60 per cent in goats.

Bones of wholesale cuts

Chuck, including neck. The weight of the bones from the chuck in sheep ranged from 0.55 to 0.98 kgm., with an average of 0.82 kgm. In goats, the average was 0.76 kgm. and the variation was from 0.61 to 0.88 kgm. Expressed in percentage, the weight of the bones in sheep varied from 17.28 to 21.84 per cent, with an average of 20.01 per cent. In goats, it varied from 26.18 to 30.33 per cent, with an average of 28.24 per cent. The ratio to the dressed weight was from 4.04 to 5.29 per cent in sheep; the average was 4.90 per cent. In goats, the average was 6.65 per cent, with a range of from 6.10 to 7.20 per cent.

Hotel rack. The bones in the hotel rack of sheep amounted to from 0.44 to 0.52 kgm., with an average of 0.47 kgm. In goats, an average of 0.41 kgm. was obtained; the fluctuation was from 0.33 to 0.49 per cent. The relation to the weight of the hotel rack in sheep was on the average of 23.71 per cent, with a range of from 17.80 to 31.97 per cent. In goats, the variation was from 30.97 to 37.08 per cent, with an average of 33.48 per cent. The relation to the dressed carcass in sheep was from 2.35 to 3.36 per cent, with an average of 2.92 per cent. In goats, the average percentage was 3.57 and the range was from 3.30 to 3.76 per cent.

Loin. The weight of bones from the loin of sheep was from 0.25 to 0.34 kgm., with an average of 0.30 kgm. In goats, the maximum weight was 0.38 kgm. while the minimum was 0.23 kgm., with an average of 0.31 kgm. The relation to the entire loin was on the average 16.70 per cent in sheep; the variation was from 12.06 to 24.64 per cent. In goats, the percentage was 28.45 per cent, with a range of from 26.61 to 31.07 per cent. The ratio to the dressed weight of the carcass varied from 1.47 to 2.50 per cent in sheep, with an average percentage of 1.89. In goats, the range was from 2.30 to 3.20 per cent, with an average of 2.72 per cent.

Breast, including shanks. The bones in the breast and shanks in sheep weighed from 0.43 to 0.60 kgm., with an average of 0.51 kgm. About the same amount was obtained from goats, the weight fluctuating from 0.46 to 0.69 kgm. and averaging 0.58 kgm. The proportion of the bones in sheep to the breast and shanks, averaged

20.37 per cent and the variation was from 17.24 to 27.91 per cent. In goats, the average percentage was 28.08, with a range of from 24.86 to 31.65 per cent. The ratio to the dressed weight of sheep varied from 2.50 to 4.26 per cent, with an average of 3.14 per cent. In goats, the average percentage was 5.15, with a range of from 4.40 to 5.73 per cent.

Legs. The weight of bones from the leg of sheep varied from 0.74 to 0.96 kgm., with an average of 0.84 kgm. Approximately the same amount was obtained from the leg of goats; the variation was from 0.65 to 1.03 kgm.; the average was 0.84 kgm. The proportion of bones to the leg in sheep was less than in goats, with an average percentage of 16.45; and the range, from 14.60 to 20.29 per cent. In goats, it varied from 19.06 to 22.39 per cent, with an average of 20.91 per cent. The ratio to the dressed carcass in sheep averaged 5.20 per cent, with a range of from 4.25 to 6.93 per cent. In goats, it varied from 6.50 to 7.69 per cent and the average was 7.31 per cent. Both in relation to the weight of the leg and to the dressed carcass, the percentage amount was consistently lower in sheep than in goats.

The total amount of bone from the entire dressed carcass was about the same in both kinds of animals. In sheep, it amounted to an average of 2.94 kgm. and in goats, 2.90 kgm. The ratio to the dressed weight of sheep was 18.05 per cent and in goats, 25.40 per cent which shows that goats possess a greater proportion of bones than sheep at the age of one and one half years.

Brain

The weight of the brain of sheep ranged from 0.10 to 0.15 kgm. and the average was 0.13 kgm. In goats, the average weight was 0.09 kgm., with a variation of from 0.09 to 0.10 kgm. In relation to the dressed carcass of the animals, the average percentage in sheep was 0.80 and the fluctuation was from 0.74 to 0.86 per cent. In goats, the range was from 0.67 to 0.91 per cent and the average was 0.84 per cent. The ratio to the live weight of sheep was from 0.38 to 0.44 per cent with an average of 0.41 per cent. In goats, the range was from 0.36 to 0.46 per cent and the average was 0.43 per cent. It may be said that sheep and goats had proportionately the same weight of brain at the age of one and a half years, but sheep being larger at this age, actually had heavier brains.

Tongue

The average weight of tongue obtained from sheep was 0.03 kgm. It ranged from 0.07 to 0.11 kgm. In goats, the fluctuation was from 0.07 to 0.12 kgm. with an average of 0.09 kgm. The ratio to the dressed weight in sheep was from 0.44 to 0.59 per cent and the average was 0.51 per cent. In goats, a higher percentage was obtained; the range was from 0.70 to 0.89 per cent with an average of 0.82 per cent. In relation to the live weight, it varied from 0.22 to 0.31 per cent in sheep, with an average percentage of 0.26. In goats, the average percentage was 0.42 and the fluctuation was from 0.36 to 0.48 per cent.

Heart

The weight of the heart of sheep varied from 0.11 to 0.14 kgm.. with an average of 0.12 kgm. That of the goats weighed an average of 0.09 kgm., with a range of from 0.07 to 0.10 kgm. The ratio to the entire carcass in sheep ranged from 0.70 to 0.81 per cent, with an average of 0.76 per cent. In goats, the average percentage was 0.76 and the variation was from 0.70 to 0.90 per cent. The proportion to the live weight of the animal was 0.39 per cent in sheep and the range was 0.36 to 0.42 per cent. In goats, it varied from 0.36 to 0.46 per cent, with an average of 0.39 per cent. It is, therefore, clear that the heart of sheep and goats is proportionately similar to their live weights.

Liver

The weight of the liver of sheep ranged from 0.39 to 0.54 kgm., with an average of 0.47 kgm. In goats, the average weight was 0.45 kgm. and the range was from 0.34 to 0.56 kgm. The proportion to the dressed carcass in sheep ranged from 2.70 to 2.94 per cent. The average was 2.84 per cent. In goats, the weight of the liver ranged from 3.40 to 4.45 per cent, with an average of 3.91 per cent. The ratio to the live weight of the animal varied from 1.42 to 1.49 per cent, with an average of 1.45 per cent. In goats, the ratio was from 1.74 to 2.24 per cent, with an average of 2.01 per cent.

Kidneys

The two kidneys of sheep weighed on an average 0.08 kgm.; the minimum weight was 0.06 kgm. and the maximum, 0.08 kgm. Those of the goats weighed from 0.04 to 0.08 kgm., with an average of 0.06 kgm. The proportion to the dressed carcass was on an average

0.45 per cent in sheep and the variation was from 0.40 to 0.50 per cent. In goats, the range was from 0.40 to 0.64 per cent, with an average of 0.54 per cent. The ratio to the live weight of the animal among sheep averaged 0.23 per cent and the range was from 0.21 to 0.26 per cent. In goats, it averaged 0.28 per cent, with a range of from 0.20 to 0.33 per cent.

Spleen

The spleen of sheep was about the same size in the different individuals studied. It ranged from 0.04 to 0.05 kgm., with an average of 0.04 kgm. The same was true in goats. The variation was from 0.03 to 0.04 kgm. with an average of 0.04 kgm. In terms of percentage, the range was from 0.22 to 0.29 per cent in sheep and the average was 0.27 per cent. In goats, there was a wider range than in sheep. It varied from 0.22 to 0.40 per cent, with an average of 0.32 per cent. The weight of the spleen of sheep in relation to its live weight varied from 0.11 to 0.15 per cent, with an average of 0.14 per cent. In goats, the fluctuation was from 0.12 to 0.20 per cent and the average was 0.17 per cent.

Lungs

The lungs of sheep were also about the same in weight in the different animals. They varied from 0.24 to 0.27 kgm., with an average of 0.25 kgm. In goats, the maximum weight of the lungs was 0.21 kgm. and the minimum, 0.14 kgm.; the average was 0.18 kgm. The relation to the dressed weight varied from 1.30 to 1.76 per cent in sheep, with an average of 1.54 per cent. In goats, the range was from 1.40 to 1.70 per cent, with an average of 1.54 per cent. The ratio of the weight of the lungs to the live weight of the animal averaged 0.79 per cent in sheep and the variation was from 0.68 to 0.92 per cent. In goats, it varied from 0.72 to 0.87 per cent, with an average of 0.79 per cent. The weight of the lungs in sheep in relation to their dressed weight is the same as that in goats. The same relationship to the live weight of the animals holds true.

Stomachs

The weight of the four stomach compartments in sheep varied from 0.79 to 1.75 per cent; the average was 1.11 kgm. In goats, the weight averaged 0.76 kgm. while the variation was from 0.70 to 0.85 kgm. Expressed in percentage, the relation to the dressed carcass in sheep varied from 5.64 to 8.75 per cent, with an average of

6.64 per cent. In goats, it amounted to an average of 6.76 per cent; the range was from 5.67 to 7.50 per cent. The ratio to the live weight of the animal in sheep averaged 3.41 per cent and the variation was from 2.93 to 4.61 per cent. In goats, it varied from 3.04 to 3.85 per cent, with an average of 3.47 per cent. Thus, it is seen that the stomachs of sheep and goats are about the same in their relation to the dressed and live weights of the animals.

Intestines

The small and large intestines of sheep weighed an average of 0.90 kgm. and the variation was 0.78 to 0.99 kgm. In goats, the range was from 0.50 to 0.70 kgm. and the average was 0.65 kgm. The relation of their weight to the dressed carcass of sheep was from 4.90 to 5.88 per cent and the average was 5.46 per cent. In goats, the range was from 5.00 to 6.70 per cent, with an average of 5.72 per cent. In relation to the live weight of sheep, the average was 2.80 per cent and the range was from 2.58 to 3.05 per cent. In goats, the variation was from 2.55 to 3.44 per cent, with an average of 2.94 per cent.

Caul

The quantity of caul in sheep was greater than that in goats. Its weight in sheep was from 2.04 to 2.80 kgm., with an average of 2.36 kgm. In goats, it varied from 0.54 to 0.71 kgm. and the average was 0.65 kgm. The relation to the dressed weight in sheep averaged 14.49 per cent and the variation was from 11.89 to 18.16 per cent. In goats, the maximum percentage was 7.10 and the minimum, 4.03; the average was 5.86. In relation to the live weight of the animals, the average percentage in sheep was 7.44 while the variation was from 5.94 to 9.43 per cent. In goats, it ranged from 2.16 to 3.62 per cent, with an average of 3.00 per cent.

Blood

The amount of blood obtained from sheep varied only slightly with a range of from 1.01 to 1.06 kgm. and an average of 1.03 kgm. In goats, an average of 1.01 kgm. was collected and the range was from 0.98 to 1.06 kgm. Expressed in percentage, the average amount of blood in sheep was 3.29 per cent of the live weight of the animal; the variation, from 2.66 to 3.93 per cent. In goats, the average percentage was 4.60 and the range was from 4.00 to 5.08 per cent. It

is evident that goats have more blood in relation to their body weight than sheep.

Head

The average weight of the head (without tongue and brain) of sheep was 1.37 kgm. It varied from 1.18 to 1.74 kgm. In goats, the range was from 0.96 to 1.08 kgm. with an average of 1.03 kgm. The head of the sheep was equivalent to 4.28 per cent of its live weight and the variation was from 3.75 to 4.95 per cent. In goats, the range was from 4.20 to 5.33 per cent and the average was 4.68 per cent.

Four shanks

The weight of the four shanks (unskinned) of sheep varied from 0.20 to 0.28 kgm., with an average of 0.24 kgm. In goats, the average was 0.44 kgm., with a variation of from 0.40 to 0.53 kgm. In relation to the weight of sheep, the range was from 0.69 to 0.92 per cent and the average was 0.76 per cent. In goats, the average percentage was 2.10; the range was from 1.88 to 2.56 per cent.

Skin

The weight of skin from sheep excluding that on the head and four shanks varied from 1.50 to 2.45 kgm., with an average of 1.88 kgm. In goats, the average was 1.28 kgm. and the variation was from 1.25 to 1.37 kgm. Expressed in percentage, the skin of sheep varied from 5.00 to 7.22 per cent of the live weight of the animal, and the average was 5.91 per cent. In goats, the variation was from 5.04 to 6.51 per cent, with an average of 5.86 per cent.

SUMMARY

1. The shrinkage in sheep during a period of 24 hours, before and after fasting, averaged 3.30 per cent; in goats, 6.79 per cent.

2. The average dressing percentage was 51.28 per cent in sheep and 51.43 per cent in goats.

3. The proportion of the different wholesale cuts to the dressed carcass in sheep and goats follows:

	SHEEP *per cent*	GOATS *per cent*
Chuck, including neck	24.60	23.59
Hotel rack	12.56	10.72
Loin	11.66	9.56

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	SHEEP *per cent*	GOATS *per cent*
Breast, including shanks	15.60	18.33
Legs	31.42	35.30
Flanks	4.16	2.67

4. The relation of the edible portion to the wholesale cuts in terms of percentage is as follows:

	SHEEP *per cent*	GOATS *per cent*
Chuck, including neck	79.99	71.76
Hotel rack	76.29	66.52
Loin	83.30	71.55
Breast, including shanks	79.63	71.92
Legs	83.55	79.17

5. The relation of the inedible or bony portions to the wholesale cuts follows:

	SHEEP *per cent*	GOATS *per cent*
Chuck, including neck	20.01	28.24
Hotel rack	23.71	33.48
Loin	16.70	28.45
Breast, including shanks	20.37	28.04
Legs	16.45	20.21

6. The ratio of the weight of blood and internal organs to the live weight of the animals follows:

	SHEEP *per cent*	GOATS *per cent*
Blood	3.29	4.60
Heart	0.39	0.39
Liver	1.45	2.01
Kidneys	0.23	0.28
Spleen	0.14	0.17
Lungs	0.79	0.79
Total	6.29	8.24

7. The ratio of the amount of offal to the live weight in sheep was 55.29 per cent; and in goats, 52.29 per cent.

8. The ratio of the amount of waste to the dressed carcass in sheep was 21.37 per cent; and in goats, 24.98 per cent.

TABLE 1

Amount and percentage of the different wholesale cuts of sheep and goats

HERD NUMBER OF ANIMALS STUDIED	CHUCK, INCLUDING NECK		HOTEL RACK		LOIN		BREAST, INCLUDING SHANKS		LEGS		FLANKS	
	Amount	Percentage	Amount	Percentage	Amount	Percentage	Amount	Percentage	Amount	Percentage	Amount	Percentage
	kgm.		*kgm.*		*kgm.*		*kgm.*		*kgm.*		*kgm.*	
Sheep												
86	4.05	28.93	1.47	10.50	1.38	9.86	1.72	12.29	4.78	34.14	0.60	4.29
88	4.20	24.71	2.23	13.12	2.01	11.82	2.47	14.53	5.42	31.88	0.67	3.94
90	4.35	24.17	2.53	14.06	2.28	12.67	2.61	14.50	5.52	30.67	0.71	3.94
91	4.67	23.35	2.64	13.20	2.57	12.85	3.45	17.25	5.82	29.10	0.85	4.25
92	2.97	21.84	1.62	11.91	1.51	11.10	2.65	19.49	4.26	31.32	0.59	4.38
Average	4.05	24.60	2.01	12.56	1.95	11.66	2.58	15.60	5.16	31.42	0.68	4.16
Goats												
398	3.35	25.00	1.50	11.19	1.33	9.93	2.27	16.94	4.60	34.33	0.35	2.61
409	2.44	22.18	1.16	10.55	1.05	9.55	2.11	19.18	3.93	35.73	0.31	2.82
410	2.76	22.08	1.46	11.68	1.24	9.92	2.18	17.44	4.51	36.08	0.35	2.80
414	2.33	23.30	1.13	11.30	1.03	10.30	1.85	18.50	3.41	34.10	0.25	2.50
419	2.54	25.40	0.89	8.90	0.81	8.10	1.96	19.16	3.54	35.40	0.26	2.60
Average	2.69	23.59	1.23	10.72	1.09	9.56	2.07	18.33	4.00	35.13	0.30	2.67

TABLE 2

Amount and percentage of edible portions of wholesale cuts of sheep and goats

HERD NUMBER OF ANIMALS STUDIED	EDIBLE PORTION OF CHUCK INCLUDING NECK			EDIBLE PORTION OF HOTEL RACK			EDIBLE PORTION OF LOIN		
	Amount	Percentage	Ratio to dressed weight	Amount	Percentage	Ratio to dressed weight	Amount	Percentage	Ratio to dressed weight
	kgm.		*per cent*	*kgm.*		*per cent*	*kgm.*		*per cent*
Sheep									
86	3.35	82.72	23.93	1.00	68.03	7.14	1.04	75.36	7.43
88	3.30	78.57	19.41	1.76	78.92	10.35	1.76	87.56	10.35
90	3.40	78.16	18.89	2.01	79.45	11.17	2.01	88.16	11.17
91	3.69	79.01	18.45	2.17	82.19	10.85	2.26	87.94	11.30
92	2.42	81.48	17.79	1.18	72.84	8.68	1.17	77.48	8.60
Average	3.23	79.99	19.69	1.60	76.29	9.64	1.65	83.30	9.77
Goats									
398	2.47	73.73	18.43	1.01	67.33	7.54	0.95	71.43	7.09
409	1.70	69.67	15.45	0.76	65.52	6.91	0.76	72.38	6.91
410	1.93	69.93	15.44	0.99	67.81	7.92	0.91	73.39	7.28
414	1.72	73.82	17.20	0.78	69.03	7.80	0.71	68.93	7.10
419	1.82	71.65	18.20	0.56	62.92	5.60	0.58	71.60	5.80
Average	1.93	71.76	16.94	0.82	66.52	7.15	0.78	71.55	6.84

TABLE 2 (continued)

HERD NUMBER OF ANIMALS STUDIED	EDIBLE PORTION OF BREAST INCLUDING SHANKS			EDIBLE PORTION OF LEGS			FLANKS	
	Amount	Percentage	Ratio to dressed weight	Amount	Percentage	Ratio to dressed weight	Amount	Ratio to dressed weight
	kgm.		*per cent*	*kgm.*		*per cent*	*kgm.*	*per cent*
Sheep								
86	1.24	72.09	8.86	3.81	79.71	27.21	0.60	4.29
88	2.04	82.59	12.00	4.60	84.87	27.06	0.67	3.94
90	2.16	82.76	12.00	4.70	85.14	26.11	0.71	3.94
91	2.85	82.61	14.25	4.97	85.39	24.85	0.85	4.25
92	2.07	78.11	15.22	3.52	82.63	25.88	0.59	4.38
Average	2.07	79.63	12.47	4.32	83.55	26.22	0.68	4.16
Goats								
398	1.68	74.01	12.54	3.57	77.61	26.64	0.35	2.61
409	1.48	70.14	13.45	3.13	79.64	28.45	0.31	2.82
410	1.49	68.35	11.92	3.55	78.71	28.40	0.35	2.80
414	1.39	75.14	13.90	2.76	80.94	27.60	0.25	2.50
419	1.41	71.94	14.10	2.80	79.09	28.00	0.26	2.60
Average	1.49	71.92	13.18	3.16	79.19	27.82	0.30	2.67

ADDITION OF POTASSIUM SULFATE AND SUPERPHOSPHATE WITH AMMONIUM SULFATE TO LIPA CLAY LOAM FOR UPLAND RICE [1]

TOMAS G. CABOTAGE

Kelley (1914) in Hawaii and Guerrero (1923) in Guam showed that superphosphate and potassium sulfate, either combined or applied singly, gave poor growth and low yield of rice. Topacio (1938) obtained similar results in Los Baños. In Topacio's experiments, the addition of superphosphate and potassium sulfate to Lipa clay loam deficient in nitrogen even resulted in decreased growth of the rice plants.

Enrile (1938) found that the addition of potassium sulfate to ammonium sulfate had not materially increased the yield of straw and of grain over that obtained from the culture supplied with sulfate of ammonia only.

Instead of potassium sulfate, Talamisan (1938) added superphosphate to ammonium sulfate and found that the yield of straw and grain was not materially greater than that obtained from the culture supplied only with ammonium sulfate.

The objects of this study were: (*a*) to determine whether or not potassium sulfate and superphosphate should be added with ammonium sulfate to Lipa clay loam for upland rice and (*b*) to determine the mixture of these fertilizers that would give good growth and high yield of upland rice.

This study was conducted in the experimental yard of the Department of Agricultural Botany from September 15, 1937 to February 26, 1939.

MATERIALS AND METHODS

Plant

Seeds of upland rice, variety Inintiw, obtained from the Department of Agronomy, were soaked in water for twenty-four hours.

[1] Experiment Station contribution No. 1427. Prepared in the Department of Agricultural Botany under the direction of Professor Rafael B. Espino.

Four seeds were sown in each pot. When about a week old, some of the seedlings were pulled up and two uniformly developed and healthy plants were left in each pot.

Soil

Lipa clay loam was gathered from a lot behind the Administration Building of the College. It was air dried in the laboratory, pulverized, sifted, and thoroughly mixed. The soil was placed in tin cans with drainage holes at the bottom. Each can contained nineteen kilograms of soil which, on analysis by the Chemistry Department, was found to contain 0.13 per cent N, 0.20 per cent P_2O_5, and 0.37 per cent K_2O.

Cultures and fertilizers

The fertilizers used were ammonium sulfate, which contained 20.6 per cent N; superphosphate, 18 to 20 per cent P_2O_5; and potassium sulfate, 48-50 per cent K_2O. These were applied at the time of planting. Two types of fertilizer mixtures were tried; namely, (*a*) mixtures of superphosphate and potassium sulfate and (*b*) mixtures of superphosphate, potassium sulfate, and ammonium sulfate. The superphosphate and potassium sulfate were added to the soil in pots in the proportion and amounts as recorded in tables 1 and 2. After harvest, the three most promising cultures were selected and to each of these cultures, ammonium sulfate, in amounts shown in tables 3 and 4, was added.

Care of cultures

The cultures were placed in the experimental yard of the Department of Agricultural Botany where they were exposed to both the sun and rain. They were watered as often as necessary and cultivated, or weeded from time to time. Care was taken to keep them free from insect pests.

EXPERIMENTS, RESULTS, AND DISCUSSION

Mixtures of superphosphate and potassium sulfate

The first trial was started on September 15, 1937, and it consisted of twenty-six triplicate cultures. On December 17, 1937, the plants were harvested (table 1). The second trial was started on July 15, 1938 and harvested on October 31, 1938 (table 2).

The cultures supplied with different mixtures of superphosphate and potassium sulfate failed to produce rice plants that differed much

from each other (tables 1 and 2). The plants in all the cultures were rather light green in color and not very vigorous. Although most of the fertilized cultures were better than the control, the difference was very little.

Thus, it appeared that the Lipa clay loam employed did not seriously lack phosphoric acid and potash.

Mixtures of superphosphate, potassium sulfate, and ammonium sulfate

An arbitrary selection of the three best cultures was made and is indicated by H's (tables 1 and 2). Most of the H's fell on cultures XX, XXIV, and XXV. To each of these cultures, ammonium sulfate was added in varying amounts and rice plants were then grown in them.

The first set was planted on September 7, 1938 and harvested on December 17, 1939 (table 3). The second trial was started on November 16, 1938 and harvested on February 28, 1939 (table 4).

When the three highest yield values in tables 3 and 4 were again arbitrarily selected and indicated by H's, it was revealed that cultures XI, XII, XVII, and XVIII in the first and second trials received the largest number of H's. The yield values of these cultures were compared with those from the control and the differences are shown in table A.

TABLE A

(*First trial*)

CULTURE NO.	SUPERPHOSPHATE, POTASSIUM SULFATE, AMMONIUM SULFATE	NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT		
				Roots	Tops	Grains
	grams					
XI	7.0-5.6-8.4	366 H	154 H	295	564	316 H
XII	7.0-5.6-11.2	396 H	149 H	382 H	591 H	280 H
XVII	7.0-7.0-8.4	322	150 H	331 H	567 H	287 H
XVIII	7.0-7.0-11.2	366 H	143	318 H	592 H	277
Control	0-0-0	100	100	100	100	100
		(*Second trial*)				
XI	7.0-5.6-8.4	866 H	160 H	827 H	793 H	722 H
XII	7.0-5.6-11.2	666	149	590	519	672 H
XVII	7.0-7.0-8.4	773 H	163 H	727 H	741 H	593
XVIII	7.0-7.0-11.2	720 H	160 H	990 H	796 H	604 H
Control	0-0-0	100	100	100	100	100

The yield values from the selected cultures exceeded those from the control, or unfertilized cultures, from about three to nearly ten

times (table A). These cultures may, therefore, be considered as the most promising in the lot and were characterized by the presence of relatively large amounts of ammonium sulfate and both superphosphate and potassium sulfate.

In tables 3 and 4, the three lowest values are indicated by L's. Cultures I, VII, and XIII received the largest number of L's in both the first and second trials. These cultures were characterized by the presence of relatively large amounts of both superphosphate and potassium sulfate and the absence (except probably of some already present in the soil) of ammonium sulfate. They may be considered as the least promising in the lot.

Cultures II, VIII, and XIV in both trials (tables 3 and 4) also produced relatively low yield values and may, therefore, be considered as among the least promising in the lot. These cultures received the least amount of ammonium sulfate.

Should superphosphate and potassium sulfate be added with ammonium sulfate?

The cultures that were supplied with different mixtures of superphosphate and potassium sulfate (without ammonium sulfate) failed to produce plants that differed much from each other (tables 1 and 2). In fact, in some cases, the control (unfertilized) was equal or even better than the fertilized cultures. Moreover, the selection of the cultures containing 5.6 to 7.0 grams of superphosphate and 5.6 to 7.0 grams of potassium sulfate were merely arbitrary.

From the standpoint of the rice plant, the effect of these fertilizers may be considered fair. From the practical standpoint, however, the application of the two fertilizers would be worthless because only a slight increase in vigor and productivity of the rice plant is obtained. It may be safe to conclude that neither superphosphate nor potassium sulfate alone should be added to Lipa clay loam for upland rice.

When superphosphate and potassium sulfate was applied with ammonium sulfate, the response of the rice plant seemed very favorable. The higher the application of ammonium sulfate the greater were the yield values obtained (tables 3 and 4). The improvements of growth and of yield, however, seemed to be due to the ammonium sulfate rather than the mixture of superphosphate and potassium sulfate used. In other words, irrespective of the mixtures of the non-nitrogenous fertilizers, the high yield values appeared to go with the high amount of ammonium sulfate employed.

It may thus be concluded that for rice, the most promising cultures contained 7.0 grams of superphosphate, 5.6 to 7.0 grams of potassium sulfate, and 8.4 to 11.2 grams of ammonium sulfate per pot. The addition of superphosphate and potassium sulfate with ammonium sulfate to Lipa clay loam for upland rice seems to be unnecessary.

SUMMARY

1. It appeared that the Lipa clay loam employed did not seriously lack phosphoric acid and potash.

2. The most promising cultures contained 7.0 grams of superphosphate, 5.6 to 7.0 grams of potassium sulfate, and 8.4 to 11.2 grams of ammonium sulfate per pot.

3. The addition of superphosphate and potassium sulfate with ammonium sulfate to Lipa clay loam for upland rice seems to be unnecessary.

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TABLE 1

Average harvest data of upland rice grown in Lipa clay loam in pots supplied with varying amounts of superphosphate and potassium sulfate (Experiment from September 15 to December 28, 1937)

CULTURE NO.	FERTILIZERS APPLIED		NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT		
	Single superphosphate	Potassium sulfate			Roots	Tops	Grain
	grams	*grams*		*cm.*	*grams*	*grams*	*grams*
I	1.4	1.4	3.5 H	89.7	3.0	10.3	10.3
II	1.4	2.8	2.5	88.0	2.8	10.5	10.2
III	1.4	4.2	2.2	95.6 H	2.5	9.8	10.3
IV	1.4	5.6	2.8	83.2	3.3 H	9.8	8.1
V	1.4	7.0	2.8	85.2	2.5	9.3	9.8
VI	2.8	1.4	2.8	89.5	2.3	10.3	9.5
VII	2.8	2.8	3.0	87.8	1.9	10.3	10.6
VIII	2.8	4.2	3.2	90.1	2.8	11.3	9.6
IX	2.8	5.6	3.0	90.3	2.3	11.3	10.3
X	2.8	7.0	3.2	89.7	2.6	11.1	11.3
XI	4.2	1.4	2.2	85.4	2.5	10.3	10.7
XII	4.2	2.8	3.0	86.4	1.8	10.9	10.3
XIII	4.2	4.2	2.7	84.8	2.0	11.4	11.0
XIV	4.2	5.6	2.2	88.8	2.2	10.2	8.3
XV	4.2	7.0	2.5	89.6	2.6	12.2	10.3
XVI	5.6	1.4	3.2	89.6	2.1	13.4 H	9.4
XVII	5.6	2.8	2.7	90.7	2.3	11.5	9.9
XVIII	5.6	4.2	3.2	87.3	2.5	11.8	9.1
XIX	5.6	5.6	2.2	94.5 H	2.9	11.6	10.1
XX	5.6	7.0	3.0	89.3	3.1 H	12.7 H	12.3 H
XXI	7.0	1.4	2.8	88.3	2.0	10.0	9.3
XXII	7.0	2.8	2.7	90.7	2.9	11.9	11.5
XXIII	7.0	4.2	2.3	90.7	2.6	11.0	11.7 H
XXIV	7.0	5.6	3.3 H	94.3 H	2.9	11.1	11.4
XXV	7.0	7.0	3.5 H	90.3	3.4 H	13.1 H	12.4 H
XXVI	Control		3.0	90.3	2.3	11.0	8.9

TABLE 2

Average harvest data of upland rice grown in Lipa clay loam in pots supplied with varying amounts of superphosphate and potassium sulfate (Experiment from July to October 31, 1938)

CULTURE NO.	FERTILIZERS APPLIED		NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT		
	Single superphosphate	Potassium sulfate			ROOTS	Tops	Grain
	grams	*grams*		*cm.*	*grams*	*grams*	*grams*
I	1.4	1.4	3.5	94.5	5.2	15.2	8.8
II	1.4	2.8	3.0	93.9	4.4	14.9	8.4
III	1.4	4.2	4.0	96.2	6.2	17.7	12.3
IV	1.4	5.6	4.3	100.2	6.8	17.1	13.5
V	1.4	7.0	3.5	95.1	4.1	14.5	12.1
VI	2.8	1.4	4.0	98.3	8.6 H	17.4	14.5
VII	2.8	2.8	4.8	99.8	7.9	17.5	13.9
VIII	2.8	4.2	4.6	96.4	8.4 H	17.4	13.1
IX	2.8	5.6	4.8	98.0	8.4 H	17.0	13.3
X	2.8	7.0	4.0	81.4	7.2	16.3	10.2
XI	4.2	1.4	4.3	100.5	8.1 H	17.8	13.3
XII	4.2	2.8	4.8	102.5 H	6.5	17.3	13.5
XIII	4.2	4.2	4.6	99.1	5.9	18.4 H	12.9
XIV	4.2	5.6	3.5	98.8	4.6	14.8	10.9
XV	4.2	7.0	3.0	86.0	5.8	12.8	8.5
XVI	5.6	1.4	4.1	96.3	4.3	14.8	9.2
XVII	5.6	2.8	3.1	97.4	7.5	17.4	11.1
XVIII	5.6	4.2	4.0	95.8	6.5	17.4	12.2
XIX	5.6	5.6	3.6	85.6	7.5	16.5	11.0
XX	5.6	7.0	4.1	105.5 H	7.2	18.8 H	15.5 H
XXI	7.0	1.4	2.6	101.4	7.2	13.2	11.0
XXII	7.0	2.8	2.8	101.0	7.4	13.4	11.4
XXIII	7.0	4.2	3.1	101.9	7.4	16.4	13.2
XXIV	7.0	5.6	6.1 H	100.4	7.3	18.9 H	15.1 H
XXV	7.0	7.0	5.5 H	101.3	7.3	19.5 H	15.8 H
XXVI	Control		3.6	101.4	6.4	18.6 H	6.9

TABLE 3

Relative values of harvest data obtained from upland rice grown in Lipa clay loam in pots supplied with superphosphate, potassium sulfate, and ammonium sulfate (Experiment from September 7 to December 17, 1938)

CULTURE NO.	FERTILIZERS APPLIED			NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT		
	Single superphosphate	Potassium sulfate	Ammonium sulfate			Roots	Tops	Grain
	grams	*grams*	*grams*					
I	5.6	7.0	0	84 L	112	92 L	112 L	77 L
II	5.6	7.0	1.4	167	118	179	170	90
III	5.6	7.0	2.8	213	130	252	298	134
IV	5.6	7.0	5.6	260	138	234	400	171
V	5.6	7.0	8.4	273	153 H	260	513	233
VI	5.6	7.0	11.2	344 H	144	244	503	257
VII	7.0	5.6	0	84 L	104 L	95 L	112 L	71 L
VIII	7.0	5.6	1.4	62 L	98 L	95 L	145	62 L
IX	7.0	5.6	2.8	211	125	234	300	124
X	7.0	5.6	5.6	233	148	297	416	236
XI	7.0	5.6	8.4	366 H	134 H	295	564	316 H
XII	7.0	5.6	11.2	396 H	149	382 H	591 H	280 H
XIII	7.0	7.0	0	69 L	111 L	95 L	93 L	63 L
XIV	7.0	7.0	1.4	113	114	163	175	90
XV	7.0	7.0	2.8	129	115	137	191	92
XVI	7.0	7.0	5.6	195	142	197	339	184
XVII	7.0	7.0	8.4	322	150 H	331 H	567 H	287 H
XVIII	7.0	7.0	11.2	366 H	143	318 H	592 H	277
XIX Control	—	—	—	100 (4.5)	100 (83.3 cm.)	100 (3.8 gm.)	100 (13.7 gm.)	100 (15.7 gm.)

TABLE 4

Relative values of harvest data obtained from upland rice grown in Lipa clay loam in pots supplied with superphosphate, potassium sulfate, and ammonium sulfate (Experiment from November 16, 1938, to February 26, 1939)

CULTURE NO.	FERTILIZERS APPLIED			NUMBER OF TILLERS	HEIGHT OF PLANTS	DRY WEIGHT		
	Single superphosphate	Potassium sulfate	Ammonium sulfate			Roots	Tops	Grain
	grams	*grams*	*grams*					
I	5.6	7.0	0	87 L	117 L	100 L	96 L	72 L
II	5.6	7.0	1.4	333	121	263	222	225
III	5.6	7.0	2.8	333	148	445	406	412
IV	5.6	7.0	5.6	487	154	427	463	482
V	5.6	7.0	8.4	467	143	500	464	476
VI	5.6	7.0	11.2	473	132	318	363	266
VII	7.0	5.6	0	67 L	95 L	64 L	53 L	45 L
VIII	7.0	5.6	1.4	313	134	436	229	270
IX	7.0	5.6	2.8	440	151	554	437	472
X	7.0	5.6	5.6	573	167 H	690	570	537
XI	7.0	5.6	8.4	866 H	160 H	827 H	793 H	722 H
XII	7.0	5.6	11.2	666	149	590	519	672 H
XIII	7.0	7.0	0	133 L	101 L	91 L	75 L	86 L
XIV	7.0	7.0	1.4	287	135	372	259	307
XV	7.0	7.0	2.8	373	135	255	281	254
XVI	7.0	7.0	5.6	673	154	645	564	584
XVII	7.0	7.0	8.4	773 H	163 H	727 H	741 H	593
XVIII	7.0	7.0	11.2	720 H	160 H	990 H	796 H	604 H
XIX Control	—	—	—	100 (1.5)	100 (67.2 cm.)	100 (1.1 gm.)	100 (7.3 gm.)	100 (5.7 gm.)

AN ASPERGILLUS LIQUEFYING GLYCERINE JELLY [1]

ISIDRO S. MACASPAC
Of the Department of Plant Pathology

WITH ONE PLATE AND ONE TEXT FIGURE

On October 15, 1940, two cakes of slimy growths (pl. 1, fig. 2) were noted inside a bottle that was almost filled with glycerine jelly, a product of Coleman and Bell Co. The bottle was opened and since then it had remained corked. One of the cakes was totally submerged; the other, which later also sank of its own weight, was still partly exposed. It was incidentally noticed that the liquid was of a much thinner consistency than the original glycerine jelly. It was suspected that the liquefaction was the result of the action of the organism. This organism should merit some study for glycerine jelly is a very common mounting medium in biological laboratories.

THE FUNGUS

Method of isolation

A very small amount of the slimy growth was transferred into a sterile potato-dextrose agar slant with the aid of a sterile platinum wire. After two days an apparently pure culture of a fungus was noted. An examination of the culture five days later indicated only a single species of organism with characteristic spore-bearing structures of an *Aspergillus*.

Appearance of colony

The Petri dish culture on Czapek's agar spread circularly and formed concentric rings which were visible from both surfaces (pl. 1, fig. 4). Any two colonies checked each other's growth on their common front. This was indicated by a clear zone separating the colonies. On account of the changing color of the heads, the culture assumed various hues [2] from white to cream, yellow, old gold, and

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[1] Experiment Station contribution No. 1428. Prepared in the Department of Plant Pathology under the direction of Associate Professor G. O. Ocfemia.

[2] The color names used in this study are those of RIDGWAY, ROBERT. 1912. Color standards and color nomenclature, 43p., 53 colored pl.; 1115 named colors. Washington, D. C.

medal bronze. The nether side of the colony was vinaceous to warm blackish brown in old cultures.

Fig. 1.—(*a*) Portion of a head of *Aspergillus wentii* Wehmer showing two sets of sterigmata, including portion of stalk (*st*), vesicle (*v*), primary (*p*) and secondary (*s*) sterigmata, and conidia (co). (*b*) A foot cell including portion of stalk. (*c*) Primary sterigma (*p*) and secondary sterigmata (*s*). (*d*) Conidia and (*e*) a germinating conidium. (Camera lucida drawings by the writer; a × 280; b × 580; c, d, and e × 1150).

Morphology

Heads. The heads (pl. 1, fig. 1) are globose and brown and measure as large as about one third to two thirds of a millimeter in diameter.

Foot cell. The base of the stalk, the foot cell, is different from the mycelium (fig. 1 *b*). It is much larger in diameter and is twisted and more thick-walled than the ordinary hyphae.

Stalk. The stalk is colorless, long, and thick-walled with one or two rather indistinct septa.

Vesicle and sterigmata. The stalk is enlarged at its apex into a globose shape. Radiating from the surface of the vesicle is a series of club-shaped cells, the primary sterigmata, each of which, in turn, bears at its apex another series of much smaller cells, the secondary sterigmata (fig. 1 *a*). The constrictions at the tip of the secondary sterigmata (fig. 1 *c*) indicate the beginning of the formation of new conidia.

Conidia. The conidia are borne in long chains at the tip of the secondary sterigmata (fig. 1 *a*). The spores easily break off from their attachments. They are light brown and pitted.

The spore germinates within 24 hours. Occasionally one to three germ tubes issue out of the spore which enlarges upon germination (fig. 1 *e*).

The perithecial stage has not been noted in the culture.

Cultural studies

Growth on various media. The organism was grown in test tubes of sterile slant Czapek's solution agar, malt extract agar, potato dextrose agar, lima bean agar, starch agar, nutrient agar, and soil. Practically, the same color changes as those noted in the Petr. dish culture (see appearance of colony under morphology) were observed in each of these media except on sterilized soil on which there was no growth. In general, the browning of the nether surface of the growth only or with the medium was most intense in the media that contain simpler carbohydrates, like Czapek's agar which contains saccharose, potato-dextrose agar, and malt agar. No such browning was noted on nutrient agar because the medium contained practically no carbohydrates; the starch agar was only slightly browned because of its more complex carbohydrates content. Growth was most abundant on Czapek's agar and potato-dextrose agar, and most scanty on nutrient agar.

Oxygen relation. The fungus is aërobic. A culture on nutrient gelatine that was growing on the surface ceased to develop when it was completely submerged in the medium.

Light relation. There was no evident difference in the rate of growth of the organism either in the dark or in diffused light. Similarly, both cultures formed heads equally readily.

Growth in media of various pH. The organism developed with apparently similar rate on Czapek's agar adjusted to various pH. The best growth was observed at pH 6.4.

Diastase production. The fungus exhibited diastatic action. The test consisted in flooding with Lugol's iodine solution a pure culture of the fungus on a Petri dish containing starch agar. A clear zone was observed around the edge of the culture while the portion as yet unaffected by the action of the diastatic organism turned blue.

Protease activity. The fungus liquefied sterile egg white and nutrient gelatine. The same media uninoculated or the checks remained unchanged.

Inoculation of glycerine jelly

Experiment 1. On April 17, a pure culture of the fungus was introduced into ten test tubes containing sterile glycerine jelly which was prepared as follows: one part by weight of gelatine was dissolved in 6 parts by volume of water and into this were added 7 parts of glycerine by volume. Two parts of the resulting mixture were diluted with one part of distilled water and then the whole thing was shaken thoroughly to mix. The mixture was warmed, placed in test tubes, and sterilized in the Arnold steamer.

After two days, the fungus started to grow and after four days there were signs of liquefaction in all of the test tubes. The uninoculated test tubes remained unchanged.

Experiment 2. Experiment 1 was repeated on 10 test tubes of glycerine jelly and the same results were obtained.

It is, therefore, concluded that the fungus was the organism that brought about liquefaction of the commercial glycerine jelly product of the Coleman and Bell Co. from which it was originally isolated. The fungus is believed to have gained access into the material in this laboratory when the bottle was opened or after the cork was replaced.

Taxonomy

Thom and Church (1926)[3] report the following cultural characterization of *Aspergillus wentii* Wehmer which, according to them, is in essential harmony with that of Wehmer who described the type species: "Colonies on Czapek's solution agar with cane sugar, deeply floccose, spreading, with sterile hyphae white or yellowish, and with heads white at first, changing through cream, cream buff, honey yellow, old gold to light brownish olive, medal bronze or in old cultures sometimes snuff brown, and in some strains producing large masses of aërial mycelium which in tubes may fill the lumen 3 cm. above the substratum; reverse of colony yellowish at first becoming reddish brown when old." The color changes undergone on the same medium of the writer's *Aspergillus* are in fundamental agreement with those of Thom and Church (1926).

The comparative morphology of Thom and Church (1926) and that of the writer's is as follows:

PARTS COMPARED	THOM AND CHURCH'S	THE WRITER'S
Stalk:		
length	2 to 3 mm., up to 5 mm.	1.5 to 3.20 mm.
diameter	10 to 12 μ, up to 25 μ	7.14 to 14.28 μ
septations	1 to 2	1 to 2
color of wall	colorless	colorless
thickness of wall	4 μ	1.78 to 3.57 μ
other characters	smooth	smooth
Vesicle diameter	80 μ	
Head	large, yellow to brown radiate (or globose)	globose, radiate
		375 to 675 μ
Sterigmata	two series	two series
primary	6 to 8 μ to 15 μ by 3 to 5 μ (extreme cases, 60 by 8 to 10)	16.8 to 19.6 μ by 36.4 to 42 μ
secondary	6 to 8 by 3 μ	5.6 to 8.4 μ by 14.0 to 16.8 μ
Conidia:		
form	pyriform to globose	globose
size	4 by 5 μ to 5 to 5–5 μ by 5 to 6 μ	4.02 to 5.35 μ; av., 4. 64 μ

The morphology of the writer's *Aspergillus* compares favorably with that of Thom and Church (1926). On the basis of this agree-

[3] THOM, C., AND M. B. CHURCH. 1926. The Aspergilli. 1st ed. ix + 272 p. Baltimore: The Williams and Wilkins Co.

ment in fundamental characteristics, the *Aspergillus* under study is identified with *Aspergillus wentii* Wehmer.

SUMMARY

1. A species of *Aspergillus* was isolated from commercial glycerine jelly. The mold liquefied the glycerine jelly and destroyed its suitability as a mounting medium.

2. The fungus grew best on Czapek's agar and potato-dextrose agar and least, on nutrient agar.

3. The fungus grew equally well in diffused light and in darkness, tolerated a wide range of pH, was aërobic, and exhibited diastatic and proteolytic activities.

4. The morphological characters are in close agreement with those of Thom and Church (1926) for *Aspergillus wentii* Wehmer with which it is identified.

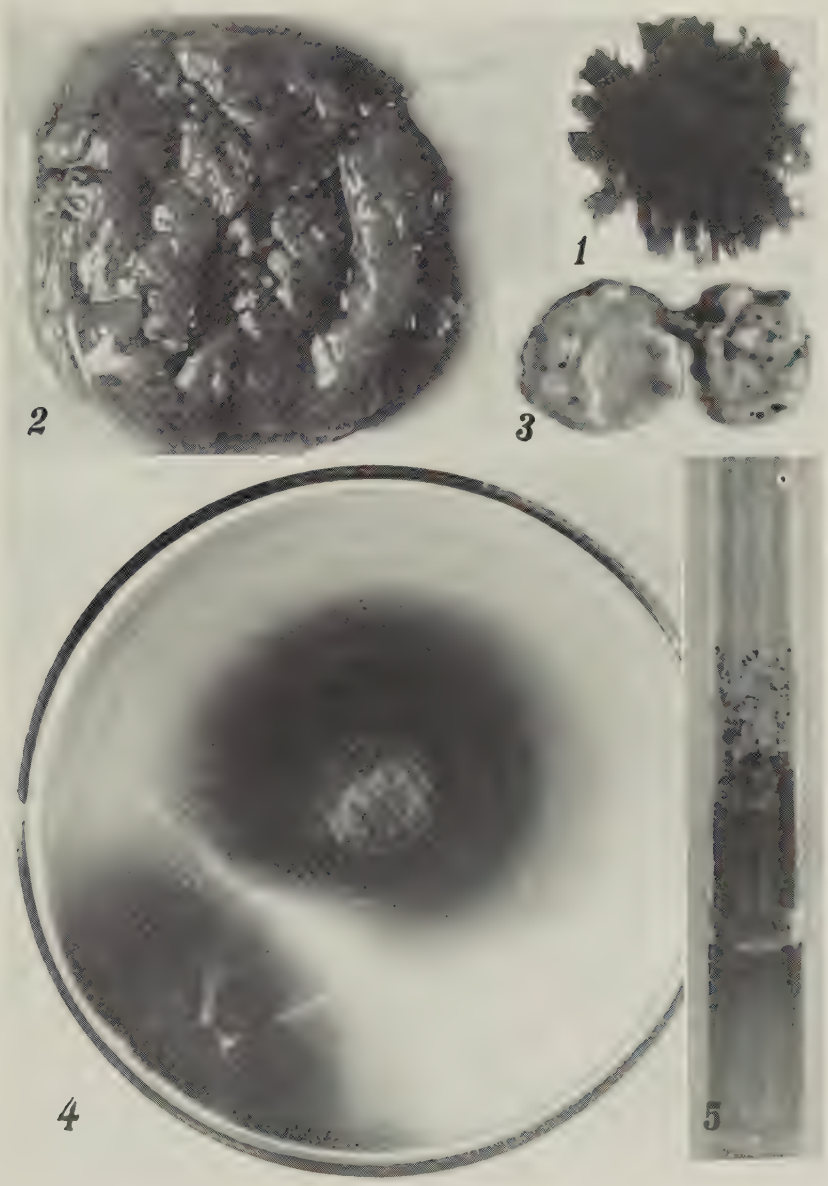

PLATE I

Fig. 1. Photomicrograph of a head of *Aspergillus wentii* Wehmer including a short portion of the stalk on which it is borne. × 75.

Fig. 2. The entire fungous growth of *Aspergillus wentii* taken from the bottle of commercial glycerine jelly.

Fig. 3. Growths of *Aspergillus wentii* in test tubes of laboratory prepared glycerine jelly ten days after inoculation with a pure culture of the fungus.

Fig. 4. A Petri dish culture of *Aspergillus wentii* on Czapek's agar. Note concentric rings and antagonism among colonies.

Fig. 5. Test tube culture of *Aspergillus wentii* on Czapek's agar. Note heads on the walls of the test tube.

Photomicograph and photographs by the Photographic Division, College of Agriculture.

A COMPARATIVE STUDY OF LAYING DUCKS RAISED IN BATTERY LAYING CAGES AND IN THE PEN [1]

CESARIO E. ALVIAR

WITH TWO TEXT FIGURES

Preliminary studies conducted to determine the possibility of using battery laying cages for laying ducks showed that the use of this system in the production of duck eggs offers bright possibilities for commercial exploitation (Fronda and Basio, 1939). These results made it necessary to compare the egg production of ducks raised in battery laying cages with those raised in the pen away from a large body of fresh water which had also been found to produce profitable results (Fronda and Mencias, 1937). In answer to this need, this study, which started on November 1, 1938 and ended on October 31, 1939, was carried out in the Department of Animal Husbandry.

MATERIALS AND METHOD

The stock consisted of 120 one-year old laying ducks divided into two lots of 60 each. Lot I was raised in battery laying cages, and Lot II in an outdoor pen. The caged layers were confined in metal laying batteries, consisting of a series of individual wire compartments measuring 40 cm. wide, 40 cm. long, and 45 cm. high, arranged in three tiers. A feeding cup was available to each layer, whereas a common watering cup was furnished for every two individuals. The outdoor lot was housed in a pen measuring 3.5 m. by 3.5 m., provided with a yard measuring 3.5 m. by 13.0 m. covered with lakeshore sand with a generous amount of shell mixed with it. The floor of the house was covered with a thick layer of rice hull. The birds had no access to a swimming pond.

Feeds. Both lots were fed the all-mash ration observed by Fronda and Mencias (1937) to be the most profitable for egg production for inland ducks. The ration of the battery lot was supplemented with 4 per cent cod-liver oil, 1 per cent common table salt, and 3 per cent ground shell. Lot II received the same mash ration

[1] Experiment Station contribution, No. 1429. Prepared in the Department of Animal Husbandry under the direction of Associate Professor F. M. Fronda.

and supplements except the cod-liver oil, since it had been found that the addition of cod-liver oil to the ration of hens raised in the pen had apparently no effect on their egg production (Fronda and Evangelista, 1939).

The cod-liver oil had a specific gravity of 0.912. It was first thoroughly mixed with a small portion of the mash to form a crumbly mixture, which was then mixed thoroughly with the rest of the mash. In this way, a uniform mash mixture free from lumps was obtained.

Green feed in the form of chopped, fresh, wild grasses, obtained in the vicinity of the laboratory, was given in unlimited amounts to both lots daily, morning and afternoon.

Feeding. The ducks were given wet mash four times a day, twice in the morning and twice in the afternoon. Each feeding time, they were given as much feed as they were able to eat in about twenty minutes. Before the first feed in the morning was given, the feeding troughs were cleaned to avoid the possibility of the ducks eating sour feed. Fresh water was supplied freely throughout the day.

Records. The initial and final weights of the birds were taken with the aid of a portable Fairbanks scale sensitive to 20 grams. In order to record the daily egg production of each bird, the eggs in the battery lot, usually gathered in the afternoon, were marked with the corresponding number of the duck. Since there was no means of identifying the individual eggs laid by the birds in the pen lot, only the total number laid each day was recorded. One hundred eggs were weighed from each lot to find out if any difference existed in their weights. All broken and abnormal ones were also recorded. A record of the weekly and monthly feed consumption of the two lots was kept. The mortality in both lots was recorded, and a post-mortem examination was made to determine the cause of death.

RESULTS AND DISCUSSION

Body weights. The average weights of the birds in each lot at the start and at the end of the experiment are shown in table 1. In this table, one can see that although the birds in both lots gained in weight, those in the battery lot had gained only 0.087 kgm., or 6.83 per cent, per bird, while those in the pen lot, 0.151 kgm., or

11.34 per cent. The tendency of lot II to fatten may partially explain the lower annual production obtained in this lot than in the other.

Mortality. The total mortality and percentage of mortality in each lot are also given in table 1. The pen lot suffered a higher mortality, 6 or 10 per cent, than the battery lot, which was only 3, or 5 per cent. In the battery lot, the 3 deaths recorded were caused by impaction of the oviduct. In the pen lot, 4 died of auto-intoxication resulting from decomposing yolk and albumen deposited in the body cavity, 1 of leg weakness, and 1 from an unknown cause. It is evident from these figures that raising ducks in battery cages reduces mortality. This result may be expected for the birds in the pen lot were exposed to inclement weather. The results obtained

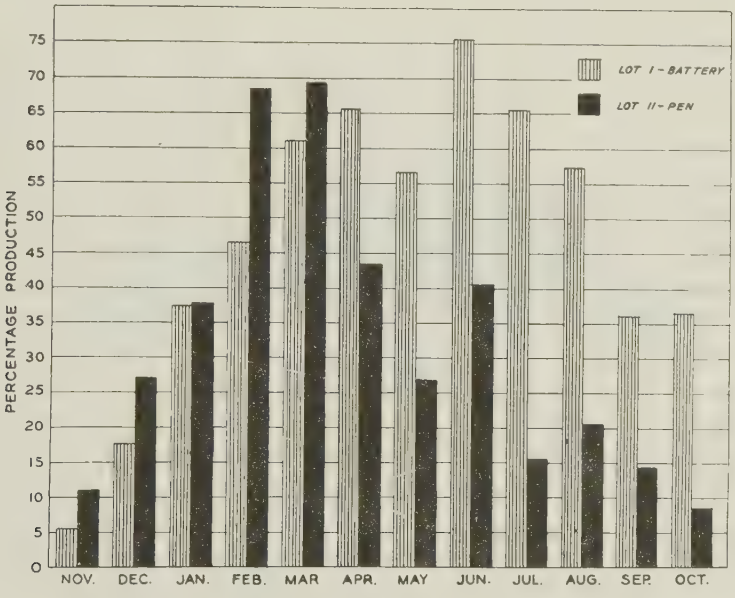

Fig. 1.—Monthly percentage egg production.

in this study conform with those obtained by Fronda and Evangelista (1939), who reported that, among chickens, mortality in the battery was significantly lower than that in laying houses.

Egg production. The annual egg production of the two lots studied is graphically illustrated in figure 1. In the battery lot, the highest egg production, 75.68 per cent, was obtained in June; and the lowest, only 5.72 per cent, in November, the first month of the

experiment. The pen lot registered the highest egg production, 69.30 per cent, in March; and the lowest, only 8.66 per cent, in October, the last month of the experiment. The pen lot was consistently higher in egg-production than the battery lot from November to March; the battery lot produced invariably more eggs from April to October.

The annual egg production is much higher, 46.7 per cent, in lot 1 than in lot II, where it was only 32.0 per cent. In terms of eggs produced, lot I birds averaged 171 eggs each, and those in lot II, only 117 eggs each per year. Fronda and Mencias (1937) found that ducks raised inland and given a ration similar to that used in this study averaged 50.4 per cent in egg production. Fronda and Basio (1939), in a study of battery-caged ducks, observed that the

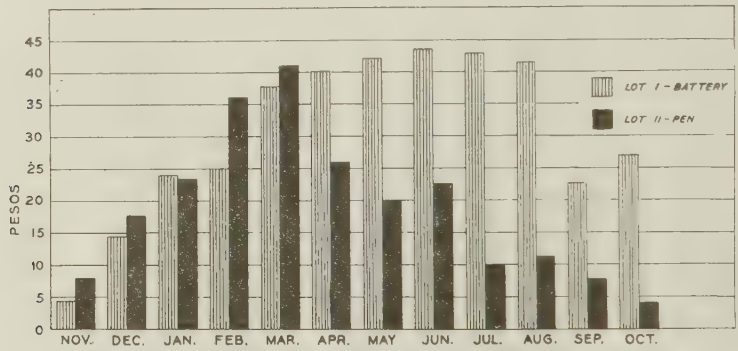

Fig. 2.—Monthly computed income from sale of eggs using Calamba prices.

average annual egg production was 221.8 eggs, or 60.8 per cent. The low percentage of egg production obtained in this study may be due to the fact that the ducks used were much older than those used by the previous investigators. The birds in this study had already laid heavily for six months in the pens before they were used in the experiment.

The average egg weight was decidedly heavier in lot I, with 62.24 ± 0.09 grams per egg, than in lot II, with 60.70 ± 0.135 grams. This shows a very significant difference of 1.54 ± 0.162 grams in favor of the battery lot. Thus, laying ducks raised in battery cages not only produced more eggs, but the eggs were heavier than those produced by ducks raised in a pen.

Amount and cost of feed consumed. The cost of feeds used in this study, based on the average current prices, was: rice bran, 4.9

centavos; fish meal, 12.7 centavos; cod-liver oil, ₱2.49 a gallon, or 72.2 centavos a kilogram; ground corn, 6.1 centavos; and common table salt, 2 centavos. A kilogram of the mash mixture supplemented with 1 per cent salt and 4 per cent cod-liver oil cost 9.87 centavos. Because of a lack of supply, the ducks were fed without fish meal for 1 week and without cod-liver oil for two weeks. Without these, the cost of the mash mixture was reduced to 9.80 centavos per kilogram. The average current price of the mash ration without the cod-liver oil supplement was only 7.4 centavos per kilogram. Being negligible, the cost of the powdered shell and the green grass given to the birds in both lots was not included in the computation of the feed cost.

From the results obtained in this study, the average consumption of the birds in lot I was 53.7 kgm., but of those in lot II, only 44.8 kilograms. Lot I actually produced 10,026 eggs; and lot II, 6,680 eggs. The birds raised in the battery cages, therefore, required only 3.78 kgm. of feed to produce a dozen eggs; the outdoor birds, on the other hand, needed 4.6 kgm.

These results show that the battery raised birds needed less feed to produce a dozen eggs than the pen raised. Although the birds in the pen ate slightly more feed to produce a dozen eggs than those in the battery cages, the cost of the feed (₱0.34) was actually lower than that of the battery lot, (₱0.37), because of the cod-liver oil supplemented to the battery ration. Fronda and Mencias (1937) reported that it cost 20.6 centavos to produce a dozen eggs in the pen. The results obtained in this study are higher owing to lower egg production and higher average current prices of the feeds. Fronda and Basio (1939) reported that ducks raised in the battery ate an average of 56.2 kgm. of feed per bird in one year. The feed consumption observed in this study was slightly lower than that reported by these investigators.

Fronda and Evangelista (1939), working on chickens, reported that battery layers ate less feed than pen layers. In this study, the battery lot birds ate more feed per bird than the pen lot. This may be partly due to the much higher egg production of the battery-raised ducks than that of those raised in the pen.

Returns from sale of eggs above cost of feed. The following average monthly wholesale prices of duck eggs in the Calamba Market were used in this study: January, ₱34 per 1,000 eggs; February, ₱32; March, ₱33; April, ₱35; May, ₱41; June, ₱33; July, ₱37;

August, ₱41; September, ₱37; October, ₱42; November, ₱39; and December, ₱35. These prices varied according to the month of the year, being generally low from February to April, when the supply of eggs in the market is heavy and high during the other months, when the egg production is comparatively low.

The total income realized from the sale of eggs above cost of feed per lot was computed on the basis of 100 birds. Lot I (battery) yielded a higher income from the sale of the eggs produced than lot II (pen). When the cost of feed is deducted, the returns gave ₱85.15 from lot I and ₱70.05 from lot II. A difference, therefore, of ₱15.15 exists in favor of lot I. One advantage of the battery lot over the pen lot is that the birds in the former produced eggs regularly, even during inclement weather, whereas the penned birds scarcely laid at that time. Thus, when the supply of eggs in the market was low, the battery birds continued to lay eggs regularly, and these were sold at high prices.

The computed income from the sale of eggs per month in pesos, using the Calamba wholesale prices of the two lots, is graphically illustrated in figure 2. In the battery lot, the highest income was obtained in June, ₱43.76; and the lowest, in November, the first month of the experiment, with only ₱4.02. The pen lot registered the highest income in March, ₱41.05; and the lowest in October, the last month of the experiment, with only ₱6.09.

Other observations. The layers confined in the battery cages were observed to be active, and except for the rough feathers and long toe nails, apparently normal in every way at the end of the experiment. The battery birds did not show any symptom of leg weakness throughout the entire period of the experiment, nor did the absence of cod-liver oil for two weeks affect the egg production. A considerable number of soft-shelled eggs was produced by the battery raised ducks. This may suggest a mineral deficiency in the ration given to this lot. In the pen, the 3 per cent ground shell supplement in the ration was apparently ample, owing probably to the fact that lakeshore sand was present in the yard. The shells of the eggs from the battery lot had a finer texture than those from the pen lot. In a number of cases, some eggs broken or partially cracked were found in the batteries. Occasionally, three eggs were laid in two days in the batteries. Some birds in the battery lot laid, even though they were molting.

SUMMARY

1. The birds raised in the pen gained somewhat more in weight than those raised in the battery laying cages.

2. The results show that raising ducks in the battery cages reduced mortality.

3. Ducks raised in the battery cages produced eggs regularly, even during inclement weather.

4. Lot I, battery-raised birds, produced an average of 171 eggs each a year; and lot II, raised in a pen, 117 eggs.

5. Of the two lots studied, lot I produced significantly heavier eggs, 62.24 grams, than lot II, 60.70 grams.

6. The ducks raised in batteries ate more than those raised in the pen. The yearly feed consumption per bird was 53.7 kgm. in the battery and only 44.8 kgm. in the pen lot.

7. To produce a dozen eggs, 3.78 kgm. of feed were needed in the battery lot and 4.60 kgm. in the pen lot.

8. Computed on the basis of 100 birds in each lot, those raised in the batteries brought in a return of ₱85.15 over the cost of feeds; those raised in the pen, ₱70.05.

9. The ducks raised in the batteries were active and apparently normal at the end of the year, although they were rough in appearance and they had rather long toe nails.

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FRONDA, F. M., AND ENGRACIO BASIO. 1939. Ducks in battery laying cages. The Philippine Agriculturist 28: 152–154.

FRONDA, F. M., AND RUPERTO EVANGELISTA. 1939. A comparative study of the economy of egg production of birds kept in the battery laying cages and those kept in the outdoor laying pens. The Philippine Agriculturist 27: 683–691.

FRONDA, F. M., AND LEON L. MENCIAS. 1937. The use of fish meal in duck rations for egg production. The Philippine Agriculturist 26: 290–294.

TABLE 1

Average weight of birds at the beginning and at the end of the experiment, and mortality in the different lots

ITEMS	LOT I (BATTERY)	LOT II (PEN)
Number of birds at the beginning of the experiment	60	60
Average weight in kilograms	1.27 ± 0.257	1.33 ± 0.185
Number of birds at the end of the experiment	57	54
Average weight in kilograms	1.36 ± 0.292	1.48 ± 0.243
Percentage of gain in weight	6.83	11.34
Percentage of mortality	5.00	10.00

COLLEGE AND ALUMNI NOTES

The officers of the Los Baños Biological Club for 1941-1942 are: Dr. Silverio M. Cendaña, President; and Dr. Valeriano C. Calma, Secretary.

Those of the Society for the Advancement of Research (SAR) are: Professor Antonio P. Racelis, President; Dr. José M. Capinpin, Vice-President; Dr. Felipe R. Salvoza, Secretary; Dr. Silverio Cendaña, Treasurer.

The following were declared honor students on the basis of their scholastic records at the close of the second semester of the academic year, 1940-1941: Prayul Siddhijai, Faustino T. Orillo, Gregorio C. Fernandez, Gil P. Nones, Diosdado B. Leyson, Guillermo P. Santos, Porfirio T. Lazaro, Nemesio G. Tan, Francisco G. Rentutar, Celestino P. Habito, Eleazar M. Galano, Luciano G. Valencia, Bonifacio R. Niones, Pedro C. Arbiso, Rizalino G. Gilpo, Alfonso N. Eusebio, Ko Wing Fung, Santos Llana, Pedro A. Abella, and Leopoldo S. Castillo.

For the first semester of the academic year 1941-1942, the following enjoy full class scholarship: Faustino T. Orillo, Sophomore; Celestino P. Habito, Junior; and Gregorio C. Fernandez, Senior. The rest of the honor students, with the exception of those who were already graduated, are partial scholars.

Several members of the College faculty delivered lectures on their respective lines before the 1941 Summer Institute held at the University of the Philippines, Manila, from April 14 to May 20. Dr. J. M. Capinpin spoke on plant freaks and how they probably came about; Dr. Francisco M. Fronda, on the use of battery cages for laying ducks; Prof. J. E. Velmonte, on financial analysis of the conditions of settlers in Koronadal; Dr. J. Banzon, on yeasts, molds, and bacteria in the service of agricultural chemistry; Dr. V. C. Calma, on boosting the farm yield with the aid of fertilizers; Dr. Agustin Rodolfo, on making domestic animals to order by long-distance siring; Dr. A. L. Teodoro, on how efficient gas engines and

gas producers are; and Dr. G. O. Ocfemia, on plant virus diseases in the Philippines.

Dr. Miguel Manresa, Associate Professor of Animal Husbandry, was elected one of the Vice-Presidents of the Seventh International Genetical Congress at the first plenary session held at Edinburgh, Scotland on August 23, 1939.

Thuan Komkris '34 is at present in the service of the Rubber Research Division of the Royal Forest Department of Thailand. Chalerm Saiyananda '41 is working in the same division. Kan Jalavicharana '37 and Yan Yong Vimuktananda '40, two other Thai graduates of the College, are connected with the Department of Agriculture and Fisheries, Thailand.

Miss Remedios O. Hizon, Instructor in Agricultural Chemistry, will be detailed to the U. P. Rural High School to teach home economics effective in June, 1941.

THE EXPERIMENT STATION

LIST OF AVAILABLE CIRCULARS

Circular No. 2.—Bud Rot of Coconut (Revised, June, 1934) - - - *By G. O. Ocfemia*

Circular No. 3.—Experimental Errors and Application of the Probable Error to and the Interpretation of Experimental Results - - - - - - - - - - - - *By Nemesio B. Mendiola* (Published as Chapter IV in *A Manual of Plant Breeding for the Tropics*, 1926, also sold by THE PHILIPPINE AGRICULTURIST at ₱3.25, paper bound, and ₱5.25, cloth bound, in the Philippines, and ₱3.50 and ₱5.50 elsewhere, postpaid.)

Circular No. 5.—Poultry Raising Made Easy (Revised) - - - - *By F. M. Fronda*

Circular No. 7.—How to Produce New Varieties of Gumamela (Hibiscus) - - - - - - - - - - - - *By Nemesio B. Mendiola*

Circular No. 8.—Horse Breeding in the Philippines - - - - - *By Valente Villegas*

Circular No. 9.—Fences for Farm Animals - *By B. M. Gonzalez and J. P. Esguerra*

Circular No. 10.—Practical Directions for Coffee Planting - - - *By Pedro A. David*

Circular No. 11.—The New College Copra Drier—Prepared in the *Department of Agricultural Chemistry* with the cooperation of the *Department of Agronomy and Extension.* (Revised by *Moises M. Kalaw*).

Circular No. 14.—Beriberi: Its Causes and Prevention - - - - - *By F. O. Santos*

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Circular No. 30.—What Should Filipino Ornamental Gardens and Ornamental Plants Be? - - - - - - - - - - *By N. B. Mendiola*

Circular No. 31.—How to Slaughter and Dress Farm Animals - - - - - - - *By Valente Villegas and M. Mondoñedo*

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